

AN ECONOMIC ANALYSIS OF LANDOWNERS'  
WILLINGNESS TO ADOPT WETLAND RIPARIAN  
CONSERVATION MANAGEMENT:  
A SASKATCHEWAN CASE STUDY

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By

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## **ABSTRACT**

Public recognition of the value of wetlands has risen quickly over the past 25 years and numerous policies and programs have been developed to address threats to the quantity and quality of wetlands. However, management of wetland resources located on private land often involves a perceived conflict between social and private interests since landowners usually cannot benefit economically from keeping wetlands on site unless they convert them to alternative uses such as agricultural crops. In order to avoid further degradation and ensure the various environmental benefits wetlands provide, there is a need for government intervention by delivering effective policies. This will be realized through an effective economic valuation process for wetland benefits.

This thesis investigates wetland and riparian zones management, with greater emphasis placed on the Prairie Pothole Region (PPR) of Saskatchewan where the majority of the land is privately owned. Using data from a survey of landowners, the perceived cost of conserving wetland and associated riparian zones is quantified through their willingness to accept (WTA) compensation for a proposed 10-year economic incentive-based program. In addition, the role of landowner and farm characteristics on this perceived cost of conservation has also been assessed. As indicated by the results from two probit models that were developed, per acre payment has a significant positive effect on the probability a landowner will accept the program offer; the average payment respondents required being \$32.58/acre. Other factors such as the landowner's previous experience dealing with the wetland, personal preferences correlated with economic benefits and landowners who have an heir to take over the farm are also found to have significant impact on their participation decision. For those respondents who did not complete the WTA question, past relative experience, knowledge about wetlands, age, and the agricultural region the farm is located are revealed to be factors that affect to the provision of an explicit answer.

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# **CHAPTER 1 INTRODUCTION**

## **1.1 Background Information**

Agriculture has been defined as the production of food, fiber and other goods by the systematic raising of plants and animals. Agriculture provides a wide variety of commodities that are exchanged in economic markets but also interacts with the natural environment in positive and negative ways to produce a range of environmental amenities and disamenities. On the positive side, farming has contributed to creating and maintaining a variety of valuable environmental products such as biological diversity, bioenergy, open space and scenic vistas (Devries, 2000). In addition, agriculture supports diverse rural communities that is not only a fundamental asset of a country's culture, but also plays an essential role in maintaining the environment in a healthy state (European Commission, 2003). On the negative side, agriculture can be a major contributor to environmental problems such as degradation of natural lands, water quality and critical habitat loss. For example, surface run-off from farmland including dissolved chemicals like nitrogen fertilizers and soluble pesticide can impair drinking water quality and degrade habitat for aquatic organisms, affecting recreational use of streams, lakes and reservoirs (Bernstein, Cooper and Claassen, 2004). Bacterial contamination from animal wastes decrease drinking water quality and decrease the quality of life in residential areas (Lichtenberg, 2000). Soil erosion from farmland affects the productivity of agricultural land and the quality of natural environment since eroded soil can clog estuaries, streams and lakes, resulting in increased flooding and destruction of habitats for many species (Lichtenberg, 2000).

Wetlands are a particularly productive ecosystem providing a wide range of environmental goods. However, wetlands and adjoining riparian zones located within agricultural landscapes can be negatively impacted by farming activities. One of the

primary direct impacts is through the conversion of wetland areas to the production of annual crops. Although wetlands are one of the most productive natural systems on earth and perform a variety of useful functions (Crosson and Frederick, 1999), they have been extensively degraded through physical and functional human activities over the last decades. For most of Canada's history, wetlands were perceived as wastelands and a nuisance, impeding residential development and reducing the land available for agriculture (Carriker, 1994). Therefore, despite the vital role wetlands play in ecosystems, they are disappearing rapidly. In the U.S., according to Blackwell (1995), approximately 215 million acres of wetlands existed in the United States at the time of European settlement. However, nine states experienced a 70 percent or greater loss in wetland extent since 1780, and nine more lost more than 50 percent of original wetlands. "Between 1954 and 1974, the net rate of wetland conversion averaged 457,600 acres per year, with 81 percent of gross wetland conversion to agricultural uses and 8 percent to urban" (Anderson and Magleby, 1997). By the middle 1970s less than half of original wetlands remained. In Canada, over 14 percent of wetland areas that existed before the time of European settlement have now been greatly transformed (Wiken et al, 2003). It is estimated that over 20 million hectares of wetlands have been converted to agricultural production since European settlement (Natural Resources Canada, 2004). Wetland losses are estimated to be around 65 percent in the coastal marshes of Atlantic Canada, 70 percent in southern Ontario, 71 percent in the Prairies, and 80 percent of the Fraser River Delta in British Columbia (Wiken et al., 2003). These areas generally coincide with the denser concentrations of people and human settlements.

In order to understand the issues surrounding wetland degradation on agricultural lands, it is important to effectively define "wetland". Wetlands have been defined differently by scientists, policymakers and natural resource agencies in several countries. Since 1977, the U.S. Army Corps of Engineers (ACE) has defined wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a

prevalence of vegetation typically adapted for life in saturated soil conditions” (Anderson and Magleby, 1997). According to *The Canadian Wetland Classification System* published by the National Wetlands Working Group of the Canada Committee on Ecological Land Classification (1988), wetland is given a similar but not identical definition as “land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment.” Ramsar convention, an intergovernmental treaty adopted in 1971 in the Iranian city of Ramsar, has promoted an agreed definition of wetland as follows:

*“areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres”* (Ramsar Information Bureau, 1998).

In addition, in order to protect coherent sites, Ramsar provides definition of wetlands beyond what are actually wetlands as supplement as to:

*“incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands”* (Ramsar Information Bureau, 1998).

The above definitions of wetland are very broad in the light of different areas of expertise and interest. However most of the current definitions are largely based on the biological principles and all include water, soil and vegetation as the three most important features of wetland and the associated riparian areas (Heimlich et al, 1998).

In recent years, society, scientists and policy makers have recognized the wide range of environmental benefits provided by wetlands. Although water is the defining feature, wetlands are important elements of the ecosystem and much more than just water. They promote and support the growth of aquatic plants and animals for part of their life cycle (Huel, 2000) and are performing such essential functions as important carbon sinks that could “sequester additional carbon from the atmosphere in form of soil organic matter” (Mitra, Wassmann and Vlek, 2003). They also provide other

benefits such as preserving water quality, controlling sediments, preventing erosion, reducing intensity of flooding, buffering the effects of storms and providing aesthetically pleasing open space and recreational sites (Gelso et al. 2008).

As the transition zones between the upland and aquatic ecosystems, riparian zones are the most effective protection for water source and support wetland functions in various ways. Although riparian areas comprise only 1-2 percent of the total land base of the Prairies, they provide a range of important environmental and economic benefits and services (AAFC, 2004). These strips of trees, shrubs and native grasses along the banks of creeks, streams and rivers could improve water quality by filtering polluted runoff before they reach the surface water (Connecticut River Joint Commissions, 2000). Protecting riparian buffers will in turn better help protect the function of wetlands.

The wide range of environmental amenities provided by wetland and riparian zones affect society in different ways and have much social benefits for those involved in agriculture. As an incentive to reduce both the onsite and offsite environmental impacts of farming on wetlands and riparian areas, governments of many countries have developed a broad range of wetland conservation policies and programs to address the loss of wetlands from agricultural landscapes at national, state, provincial and local levels. Most countries have implemented both wetland specific policies and broader agricultural and land use policies that influence management decisions (Farnese and Belcher, 2006).

At a global scale, there are many international agreements that are at least partially aimed at wetland conservation such as the first modern intergovernmental treaty Ramsar and another multilateral environmental agreement, the Convention on Biological Diversity (CBD). Canada, as a large wetland holder in the world, has broadly committed itself to conserve wetland in a number of international agreements including both Ramsar Convention and CBD as described above. In addition, Canada has also developed many national discussion and fact sheets on wetland issues identifying and addressing major problems existing such as the *Federal Policy on*

*Wetland Conservation* (FPWC) and *Canadian Environmental Assessment Act*. At a regional scale, many provinces have also developed their own wetland policies and legislation. Ontario's primary method of wetland protection comes via the *Provincial Policy Statement* under the *Planning Act* and the *Great Lakes Wetlands Conservation Plan* (GLWCAP) (Rubec and Hanson, 2008; Environment Canada, 2008). In Atlantic Canada, the main policy for wetlands development in Prince Edward Island are *The Wetland Conservation Policy for Prince Edward Island* (WCP-PEI) which was introduced in 2003; wetlands in Nova Scotia are managed primarily by its *Environment Act of 1994-1995* (2006) and *Wetland Designation Policy*; the 2002 *New Brunswick Wetland Conservation Policy* (NBWCP) has outlined New Brunswick wetlands conservation objectives and means to achieve them (Rubec and Hanson, 2008). In prairie regions, the *Water for Life* strategy that was adopted by the Alberta provincial government in 2003 outlines the basic policy foundation for sustainable wetlands management and supply. The report, with recommendations for the renewal of this strategy, was released by Alberta Water Council in January 2008 (Alberta Water Council, 2008). Manitoba developed the Manitoba's Water Policies in 1990 and in 2007, the mandate and the members of the new Manitoba Water Council were announced to provide various stakeholders with watershed management plans (Manitoba Wildlands, 2008). Saskatchewan, our study area, produced its Saskatchewan Wetland Policy in 1995. This policy is currently under revision by Saskatchewan Watershed Authority (SWA) to target increased efforts at wetland retention and provide guidance to drainage policy on privately owned lands (SWA, 2007).

In general, current public policies implemented on wetlands have largely focused on mitigating the over-exploitation of wetlands and riparian areas rather than balance the public's interest in conserving wetlands and landowners' interests in converting to the production of commodities. In fact, one of the primary explanations for wetland degradation is the lack of motivation of landowners to provide the environmental goods wetlands produce. Although wetlands and associated riparian

zones perform a variety of functions that benefit the public, the actual value of these goods and services is not priced properly by the free market. Most of these public goods produce “benefits that accrue to society at large or to individuals other than the wetland owners” (Heimlich et al, 1998). Therefore private owners of wetlands are not able to profit from these wetlands and there is an incentive for them to convert wetlands to the production of market commodities, such as agriculture or urban development even though such conversion can be costly to society (Heimlich et al, 1998). We usually define this situation in economic theory as a “market failure” which would result in a suboptimal allocation of wetlands being conserved from a social perspective. In such cases, there is an economic rationale for governments to encourage political programs to correct the market failure so as to better protect wetlands within the private agriculture land (Bernstein et al. 2004).

## **1.2 Problem Statement**

Currently the environmental goods produced by wetlands on private agricultural land are provided at a suboptimal level from the social perspective. In order to avoid further degradation activities, increase the supply of wetlands and achieve the socially efficient stock, there is a need for government intervention through delivering effective policy, namely economic incentive-based program. This will be realized by effectively quantifying the cost of landowner adoption of farm management plans that conserve and enhance healthy functioning riparian and wetland areas, and by investigating various attributes’ impacts on individual landowner’s preservation choices.

## **1.3 Objectives**

The primary objective of this research is to quantify landowners’ perceived cost of conserving wetland and riparian zones and to evaluate the role of landowner

and farm characteristics on this perceived cost of conservation. The specific objectives of this research are:

- 1) To evaluate international and national wetlands conservation policies to understand the primary policy tools used to provide wetland and riparian environmental goods on agricultural landscapes.
- 2) Estimate the financial incentive required for landowners to conserve wetland and riparian zones on their land within two study areas in Saskatchewan.
- 3) Assess the influence of farm and landowner characteristics on the magnitude of the economic incentive required.
- 4) Develop policy recommendations relevant to the study area farm and wetland and riparian zone characteristics.

## **1.4 Organization of Thesis**

The current research is part of broader interdisciplinary research project entitled “Economics, Greenhouse Gas and Policy Implications of Wetland and Riparian Management on an Agricultural Landscape” which is directed by Ducks Unlimited Canada in conjunction with Advancing Canadian Agriculture and Agri-Food (ACAAF). The data information from a mail-out survey which was conducted for this research was also used by Cuddington (2008) which focused on land use allocation and management of wetlands in the PPR, and the role of carbon markets in assisting publicly funded wetland conservation programs.

This thesis is organized in the following manner. Chapter 2 presents an overview of the status of natural resources and a policy background regarding wetlands and riparian areas within agricultural landscapes, particularly in Canada. The chapter begins with a brief introduction of wetlands and riparian zones, their values and threats to them. The current policies for wetland protection and development are reviewed through the relevant literature. The chapter concludes by examining the market and non-market valuation mechanisms for valuing wetlands.



The theoretical framework utilized in this research is elaborated in chapter 3. In this chapter why a “market failure” may occur with respect to wetland outputs and how it would affect distribution of land use in privately owned agricultural landscape have been identified. With the help of a graphic model, the role of a financial incentive as a policy tool to encourage conservation of wetlands is examined as a solution to this problem.

Chapter 4 contains the geological and biological information of the two research areas and the description of data collected. The explanation of the econometric model applied for the empirical work of this analysis is also included in this chapter.

Chapter 5 presents a description of explanatory variables adopted as well as their expected influence. The results for the empirical work for this analysis are then provided, along with a discussion of significant variables. In this chapter it is shown how landowners’ characteristics influence participation in wetland conservation programs and the amount of economic incentive required.

Lastly, chapter 6 summarizes the results of the thesis and offers the limitation of the study. Topics for future research are suggested.

## **CHAPTER 2 LITERATURE REVIEW**

### **2.1 Introduction**

Wetlands and riparian areas are vital in supporting people's life in that they supply a range of environmental benefits. However, historically, wetlands were considered a health hazard and were largely altered for other uses. The conversion actions have lasted for quite a long time in human history with financial and political encouragement, until in recent decades increased recognition of the value of wetlands and associated riparian areas, public opinions and wetland policies began to shift from exploitation to preservation and restoration. Preventing further wetland degradation and improving wetland stock have become the primary objectives of current wetland policies. With the purpose to deliver efficient policy for mitigating the impacts of human production activities on wetlands and increase wetland supply, valuation of economic costs and benefits of wetlands is necessary. The valuation can help examine public's values of wetland good and services and explore the appropriate policy for landowners to conserve wetland.

This chapter starts with an introduction of the basic background of wetlands concerning their values and status. A review of various wetland policies implemented in various countries and regions is then presented. Approaches taken in EU and US are discussed for comparison purpose. The chapter concludes with an examination of existing wetland valuation methods.

## **2.2 Environmental Goods in Agricultural Landscapes**

### ***2.2.1 Agriculture and Environment***

Farming is an activity whose significance goes beyond simple food production and food and fibre commodities but also inevitably depends in major ways upon the natural environment and can exert a profound influence over it. Specifically, on one side, many valuable habitats are maintained by extensive farming operations and a wide range of wild species rely on farming for their survival. On the other side, intensive agricultural practices, in many situations, can also have an adverse impact on natural environmental resources (European Commission, 2003). According to a general state assessment of the U.S. Environmental Protection Agency (EPA) in 2000, agriculture is the leading source of pollution in 48 percent of river miles and 41 percent of lake acres (excluding the Great Lakes) and a major source of impairment in 18 percent of estuarine waters in United States in that they do not support designated uses (Wiebe and Gollehon, 2006). As the intensity of agricultural production has increased in recent decades, the impact on the natural environment throughout the production chain has become increasingly apparent. The economy is gradually damaging the surrounding environmental foundation on which it rests. All the natural resources may simultaneously affect environmental spillovers from agriculture production like soil and water pollution, pesticide poisonings, fragmentation of habits, loss of wildlife and environmental degradation as a result (Lichtenberg, 2000). Wetlands and corresponding riparian buffer zones are an example of the environmental resources that are suffering the impacts that come from farming activities. The following sections will first review the status of the remaining wetlands and then examine the functions and benefits of wetlands and riparian zones.

## ***2.2.2 Status and Functions of Wetland and Riparian Zones***

### ***2.2.2.1 Wetland Status***

Wetlands play a vital role in the global environment as sources of biological, cultural and economic diversity. Wetlands can be found in all climate zones from the tropics to the tundra regions (Mitra et al. 2003). However, an accurate assessment of the size and distribution of the global wetland resources is not available due to their scattered nature. As reported by Ramsar, the UNEP-World Conservation Monitoring Centre has estimated there are about 570 million hectares of wetlands (5.7 million square kilometres) – roughly 6 percent of the Earth’s land surface – of which 2 percent are lakes, 30 percent bogs, 26 percent fens, 20 percent swamps, and 15 percent floodplains (Ramsar Information Bureau, 2007a). Mitsch and Gosselink’s standard text book *Wetlands*, 3<sup>rd</sup> edition (2000) has suggested that 4 percent to 6 percent of the Earth’s land surface is wetland (as cited in Ramsar Information Bureau, 2007a).

As indicated by the definitions presented in the first chapter, wetlands are neither entirely land nor entirely water. They may be covered or saturated with water throughout the year or partially or completely dry for months (Crosson and Frederick, 1999). The Ramsar convention divides wetlands into 3 major categories to provide a very broad framework and to aid rapid identification of the main wetland habitats represented at each site (Ramsar Information Bureau, 2007a). These three types are: Marine/Coastal Wetlands, including coastal lagoons, rocky shores, and coral reefs, Inland Wetlands, including inland deltas, waterfalls and mangrove swamps and human-made wetlands, including fish and shrimp ponds, farm ponds, irrigated agricultural land and reservoirs). With the help of this broad classification system, the types of those globally threatened wetlands and those wetlands that are under-represented in the List of Wetlands of International Importance can be easily identified by the convention (Mitra et al. 2003).

In Canada, wetlands, which occur all over its land mass, are typically the

biological reservoirs in grassland, forested, arctic landscapes and coastal areas, hosting and sustaining many of the country's natural assets such as plants, birds, insects, and mammals (Wiken et al, 2003). According to Wiken et al, as reported by National Wetlands Working Group, being a large holder of wetlands, Canada possesses an estimated 24 percent of all wetlands in the entire world. More than 1.6 million square kilometers of wetlands are located in Canada and comprise about 18 percent of Canada's total land area distributed among 15 terrestrial ecozones (Wiken et al, 1996). The distribution of wetlands varies greatly across Canada but most of the wetlands are located in Manitoba and Ontario. The largest concentrations of wetlands are in the Boreal Shield, Boreal Plains, Hudson Plains and Taiga Plains. Figure 2.1 (Wiken et al, 2003) shows the distribution and relative percentages of wetlands based on the ecozones of Canada. The darker lines in the figure show the larger ecozone boundaries. Based on the above national wetland situation, a national framework presenting standardized criteria and definitions, *The Canadian Wetland Classification System*, classifies Canadian wetlands into three hierarchical levels: (1) *class* – based on the overall genesis of the wetland ecosystem, (2) *form* – based on the surface morphology and pattern, landscape setting, water type and morphology of underlying mineral, and (3) *type* – based on the vegetation physiognomy (Government of Canada, 1991).

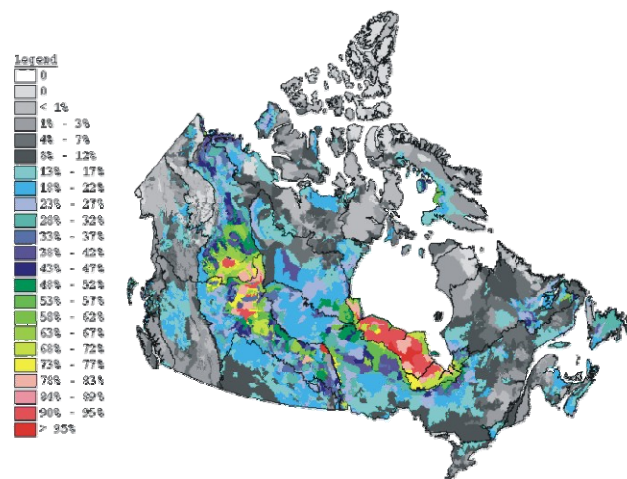


Figure 2.1 Percentage of land cover represented by wetlands

Source: Wiken et al. (2003): Figure 1

The province of Saskatchewan contains approximately 11 percent of Canada's total wetlands (Huel, 2000). Although wetland numbers and size are not constant through the year and often change with the climate, "it is estimated there are about 1.5 million wetlands covering 1.7 million hectares (4.2 million acres) in the agricultural region of the province" (Huel, 2000). Most Saskatchewan wetlands are small although the number is considerable. "Over 80 percent of the province's wetlands cover less than one hectare and less than one quarter of one percent of Saskatchewan wetlands are greater than 50 hectares in size" (Huel, 2000). A more detailed discussion of Saskatchewan wetlands will be provided in Chapter 4.

Many wetland functions are also dependent on the riparian areas (Connecticut River Joint Commissions, 2000). Riparian buffers, which are described as "green ribbons of lush vegetation", are often interpreted as the interface between human land use and a water body. Riparian areas are often narrow bands located between the wetland basin and the surrounding upland area and form a small proportion of the landscape. However, they are significant in ecology, environmental management and civil engineering due to their role in soil conservation, biodiversity support and the influence on aquatic ecosystems (Farnese and Belcher, 2006). On the Prairies, the increased moisture found in these areas produces unique plant communities that differ noticeably from surrounding crop and pasture land (AAFC, 2004). They protect aquatic environments from excessive sedimentation, reduce the amount of nutrients, chemicals and pathogens reaching the wetland, assist in recharging aquifers and supply shelter and food for many aquatic animals. For wetland conservation policy to meet objectives of particular ecological functions, it will be essential for the riparian zones and not just the wetland basins to be conserved (Farnese and Belcher, 2006).

#### **2.2.2.2 Benefit of Wetlands and Riparian Zones**

Wetlands are a vital element of the national and global environment and provide a number of useful ecological and economic functions and services to society

(Table 2.1). These functions and services can be divided into two categories: use value and non-use value. Typically, “use” value refers to values stemming from situations where people have direct interaction with the resource while “non-use” value is not related to the actual use of the resource. Further, use value could be grouped according to whether they are direct or indirect, marketable or non-marketable (Huel, 2000; Mitra et al. 2003, Barbier, Acreman and Knowler, 1997; Cuddington, 2008).

The crucial role riparian areas play in the environment cannot be neglected when we discuss the various roles provided by wetlands. These buffers are complex ecosystems that supply habitat and improve the wetland communities they border and buffer. Environmental benefits provided by riparian zones include: a) filter sediments -approximately 50-100 percent of the sediments being transported from adjacent upland areas could be settled out depending on the width and complexity of the buffer; b) assist wetlands in slowing the velocity of the runoff water; c) provide aesthetics value with green screen along waterways (Connecticut River Joint Commissions, 2000). Economic benefits provided by riparian zones include adding fertility to soils, providing carbon sequestration and supplying forage and high quality water for livestock. With good management of riparian buffer zones, livestock producers could earn stable incomes from increased forage productivity (AAFC, 2004).

Table 2.1 Classification of economic wetland benefits

Benefit Class	Benefit Category	Wetland Benefits	Explanation
Use value	Direct Use Market	Transportation	Wetlands provide an array of basic services to the society that is close to people's daily life. These services could be priced and traded in the open market.
		Drinking water	
		Irrigation	
		Electricity	
		Carbon sequestration	
	Direct Use	Recreation	Wetlands have special attributes to outdoor recreations such as fishing, hunting, boating, bird-watching and canoeing. Besides, wetlands produce timber and grazing area for livestock, constitute a source of aesthetic inspiration, support educational and scientific activities and form the basis of important local traditions.
	Non-market	Aesthetic	
	Indirect Use Non-market	Water storage	The water storage capacity of wetlands can help to receive and store surplus water flows after a storm by slowing the movement of water into tributary streams, thus allowing potential floodwaters to reach rivers over a longer period of time.
		Shoreline protection	Healthy vegetation found in wetland along the coast and shorelines helps to stabilize shoreline from wave damage and erosion.
		Wildlife support	The lush growth of wetlands provides the energy to maintain complex food chains and supports literally hundreds of species of insects, birds, mammals, fish, amphibians, reptiles, and other creatures large and small by habitat and food supply.
		Climate impacts	Wetlands are an important source of oxygen and a vital element of the natural evapotranspiration. They are able to return over two-thirds of their annual water inputs to the atmosphere through plant evaporation.
Non-Use value	Non-market	Existence value	An intrinsic value people place on the wetland independent of its actual use
		Bequest value	



### **2.2.3 Threats to Wetlands**

#### **2.2.3.1 Wetlands at Risk**

Despite the fact that wetlands and the associated riparian areas are vital to the ecosystem and the important multiple values they provide to humanity, wetlands are disappearing rapidly and continue to be among the world's most threatened ecosystems. Human activities cause wetland degradation and loss in many ways such as ongoing drainage, conversion, pollution, and over-exploitation of the resources (Heimlich et al, 1998; Natural Resources Canada, 2004; Huel, 2000). As examined by Crosson and Frederick (1999):

*...draining and protecting lands from floods for farming, mining, forestry, urban development, and highway construction may eliminate the water essential to the existence of a wetland. Changes in the landscape associated with these activities may result in erosion that degrades or destroys wetlands. Dam and reservoir construction, channelization and dredging for navigation, reservoir management, water diversions, drainage, and discharges of used water are likely to alter the quantity, quality, or timing of flows for wetlands.*

Over the last 100 years, it is estimated that half of the world's wetlands have been destroyed due to human overuse or conversion activities (WWF, 2008). Conversion of swamps, marshes, lakes and floodplains for agriculture, housing and industrial schemes has led to dramatic alterations of wetlands landscapes and ecosystem functioning (WWF, 2008).

During most of the past century in Canada, the country's national biodiversity did not attract enough attention except in the sense of harvesting products such as furs, timber and fish. In order to reach urban development goals, grasslands and wetlands have often been considered as obstacles that need to be transformed. Especially in the southern prairie area, around the lower Great Lakes and along the St. Lawrence Lowlands, many of the productive wetlands have been exploited (Wiken et al, 2003). It

is estimated that about 20 million hectares, about 85 percent of the total wetland loss, have been destroyed due to agriculture development since the early 1800's (Wiken et al, 2003). Other factors also contribute to wetland degradation including recreational development, hydro development, lake-level management, and drainage for forestry and peat harvesting. These losses are in the most productive ecozones – the Prairies Ecozone and the Mixed Wood Plains Ecozone (Wiken et al, 2003). Figure 2.2 (Natural Resources Canada, 2004) provides a general idea of wetlands at risk in Canada. This map indicates that wetlands near urban areas are under the greatest pressure but are the most valued areas for educational or recreational purposes.

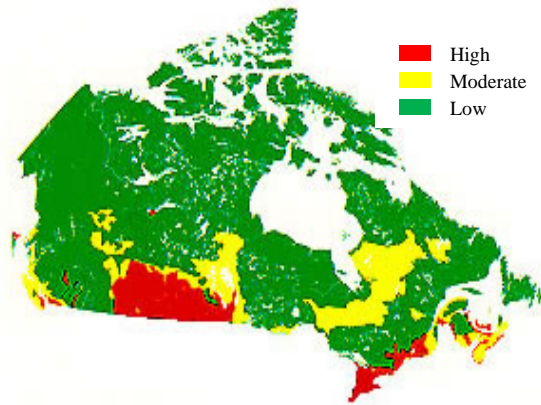


Figure 2.2 Wetlands at risk

Source: Natural Resource Canada (2004)

In Saskatchewan, the area of highest historic wetland density, the prairie pothole region (PPR), coincides with areas of intensive agricultural production. As a result, agricultural activities have had the largest impact on Saskatchewan wetlands. Since wetlands compete with cropland acreage, decrease efficiency of field operations and may contribute to crop depredation by waterfowl, which can occasionally be numerous, draining and converting wetlands to crop production continues to be the most serious threat facing Saskatchewan wetlands (Wylynko, 1999; Huel, 2000).

#### **2.2.3.2 The Role of Policy in Wetland Loss**

Governmental policies used to play an important role promoting North

American wetland degradation and conversion by implementing drainage encouragement programs. Within the United States', from the mid-1950s until the 1970s, wetland drainage and cultivation activities were supported by direct and indirect agricultural policies. In the 1600s, the United States possessed more than 200 million acres of wetlands in the lower 48 states (EPA, 2001). Since then, extensive losses have occurred, and more than half of the original wetlands have been drained and converted to other uses with the explicit encouragement of federal government policies and local cooperative efforts. Between 1954 and 1974, the net rate of wetland conversion averaged 457,600 acres per year, with 81 percent of gross wetlands conversion to agricultural uses and 8 percent to urban (Anderson and Magleby, 1997). The drainage focus also shifted from the Midwest to the Delta and Gulf region and the southeast (Heimlich et al, 1998). For a long period of time (from the mid-1950s to 1983), agriculture was the major cause of wetland losses in the 48 states because federal government policies, throughout the country's history, provided incentives to landowners to convert wetlands to crop and animal production by directly or indirectly making it profitable to do so (Crosson and Frederick, 1999). Agriculture has accounted for 53 percent of the gross conversion during that period of time and then dropped to 20 percent of the total wetland conversion between 1982 and 1992 (Anderson and Magleby, 1997). Since then, with significant changes in existing policy and the development and implementation of new policies, the rate of loss has slowed in the U.S.

Canadian wetland conversion has followed a similar pattern to what has occurred in the U.S. To enable agricultural development in many areas, much of the grassland and wetland area was transformed to agricultural production to provide agricultural commodities. For example, during the three decades after the Second World War, wetland loss was encouraged through burning, draining and conversion to agricultural use to meet an increasing international need for grains and oilseeds. The objective of agricultural policies in this period of time was to eliminate these marginal lands as policy makers did not recognize the impact the programs initiatives had on the

Canadian landscape. Subsequently this form of wetland management was considered as a unsustainable land use. Working in cooperation with federal and provincial agricultural departments, and other agricultural and conservation organizations, acceptable methods of modifying policies have gradually been developed (Cox, 1993).

## **2.3 Wetland and Riparian Policy Overview**

### **2.3.1 Introduction**

Public recognition of the value of wetlands has risen quickly over the past 25 years (Heimlich et al, 1998). Society has realized the serious results of wetlands overexploitation and also the valuable functions and services provided by wetlands. Numerous policies and programs have been developed to decrease these impacts on the quantity and quality improvement of wetland resources to prevent further loss and increase stock. Both national action and international cooperation have been encouraged to provide a variety of mitigation measures and wise use of wetlands and their resources (Mitra et al. 2003).

One approach to address wetland loss is wetland mitigation policy. Usually mitigation policy could be outlined as a three-step process: 1) avoidance; 2) minimization; and 3) compensation (Lynch-Stewart et al. 1996; Grose and Cox, 2000; Rubec and Hanson, 2008). The definition of this mitigation hierarchy reflects a philosophical procedure to achieve wetland conservation goals. As the first step of a mitigation effort, *avoidance* is the first-best approach to conserve wetlands since it involves prevention and will save development costs involved for subsequent minimization and compensation practices; *minimization* activity occurs when wetlands conversion has to take place and efforts are applied to reduce adverse effects to the lowest level; *compensation* acts as a makeup measure to offset any unavoidable and undiminished damages to wetland functions and typically includes restoration and enhancement (Lynch-Stewart et al. 1996). Although compensation is the last step of

the mitigation process, it plays an essential role in conserving wetlands due to the insufficient effort of avoidance and minimization in reducing loss. Compensation deters the impact of wetland loss on society and also insures the achievement of avoidance and minimization.

In order to meet wetland mitigation and compensation objectives, policy makers have established a wide variety of policies and regulations. Policies for conserving wetlands can include direct to indirect and voluntary to involuntary, for example education and technical assistance, financial incentive, command regulations and pollution tax, trying to head off the risks of environmental degradation while still encouraging landowners to continue to play a positive role in the maintenance of the countryside and the environment (European Commission, 2003; Claassen et al. 2001). Each policy tool has different characteristics. The use of a completely voluntary program (e.g. education, research and technical assistance etc.) is often regarded as helpful in improving landowners' awareness of benefits of conservation plans but the effectiveness is very uncertain due to voluntary participation rate and uncertain benefits landowners get from programs (Claassen et al. 2001). Direct compulsory regulations (pollution tax, environmental law, corporate law etc.) can be effective in ensuring participation and improving environmental quality but have been largely avoided due to low flexibility and high costs associated with enforcement (Claassen et al. 2001; Cuddington, 2008). Incentive payment programs (cost-share programs, land retirement programs, environmental tax, etc.), increase the probability landowners adopt the environmentally desirable practices relative to information programs while at the same time allow greater flexibility than regulatory approaches and may represent a more realistic tool to realize wetland conservation goal (Claassen et al. 2001).

Despite the apparent effectiveness of economic incentives in encouraging landowners to take part in wetland provision programs, the optimum social conservation goal may not be realized through a single policy mechanism (Cuddington, 2008). For example, compulsory regulations may still be necessary to eliminate high environmental risk activities and knowledge improvement programs are essential to

assist landowners to make rational decisions. It can be argued that well-integrated mandatory and voluntary policy may enable incentive-based economic plans to achieve the best result of wetland loss prevention and lost wetland function replacement.

When designing a wetland policy, another important factor environmental managers and decision makers need to consider is the cost-effectiveness of management practices. Since public funding is limited, policy should be designed to find the least cost way to meet the defined environmental benefits objectives (Cuddington, 2008). This will be based on a full understanding and an effective economic valuation of the goods and services provided by wetlands. This discussion is included later in this chapter in section 2.4.

The remainder of this section is focused on regulations and policies that govern wetlands across the world. Whether these policies are successful should not only be judged by the enforcement results and capability in meeting planned objectives but also by their flexibility and cost-effectiveness. International agreements are first introduced, followed by regional ones.

### ***2.3.2 International Agreements on Wetland***

In terms of global wetland policy, the Ramsar Convention that was signed on February 2, 1971, in the Iranian city of Ramsar, is an intergovernmental treaty addressing wetland conservation. The goal of the Ramsar Convention, as adopted by the Parties in 1999 and refined in 2002, is “the conservation and *wise use* of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving *sustainable development* throughout the world.” (Ramsar, 2007). In 1987, during the Ramsar meeting of the Conference of the Contracting Parties in Regina, the concept of *wise use* and *sustainable development* of wetlands were defined as follows (Ramsar Convention Secretariat, 2007):

*“The ‘wise use’ of wetlands is their sustainable utilization for the benefit of*

*mankind in a way compatible with the maintenance of the natural properties of the ecosystem, and ‘sustainable development’ of a wetlands refers to development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”*

Further *wise use* as a sustainable development mechanism has subsequently been recognized by the Ramsar Convention in 1996 through its adoption of the Convention’s mission statement, in the Strategic Plan 1997-2002, and reaffirmed by this amended mission statement in the Strategic Plan 2003-2008 as (Ramsar Convention Secretariat, 2007):

*“the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.”*

The provisions of Ramsar are relatively straightforward and general. Over the years, the Conference of the Contracting Parties has further developed and interpreted the basic tenets of the treaty text and succeeded in keeping the work of the Convention abreast of changing world perceptions, priorities, and trends in environmental thinking (Ramsar Information Bureau, 2007b). There are presently 159 Contracting Parties to the Convention, with 1838 wetland sites, totaling 161 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance (Ramsar, 2009a).

Another multilateral environmental agreement relevant to wetland conservation is the Convention on Biological Diversity (CBD), signed in 1992 at the Rio Earth Summit by 150 leaders from participating countries. This international agreement is dedicated to the promotion of sustainable development and is also a significant document for the purpose of wetland conservation (Farnese and Belcher, 2006). The three main objectives of this convention are to conserve biodiversity, to enhance the sustainable use of the components, and to ensure fair and equitable sharing of benefits arising from genetic resources (CBD, 2008a).

As a natural major carbon sink, wetlands perform an important role in sequestering carbon from the atmosphere. *The Kyoto Protocol* is an international

agreement adopted at the third Conference of the Parties to the UNFCCC (COP 3) in Kyoto, Japan, on 11 December 1997 with the objective of reducing greenhouse gas (GHG) that causes climate change (UNFCCC, 2008). Under this protocol, industrialized countries are required to reduce GHG such as carbon dioxide, nitrous oxide and methane by a collective average of 5 percent below their 1990 levels by the commitment period of 2008-2012.

In North America, the North American Waterfowl Management Plan (NAWMP) was developed by Canada, the United States and Mexico to cooperate in the planning and implementation of projects to restore waterfowl population to their average 1970s level (NAWMP, 2008). Joint ventures were established according to identifiable waterfowl habitat areas of major concern when the agreement was signed so as to pursue biological-based conservation goals throughout the continent (Sprung, 1999). The plan recognized that the recovery of the waterfowl population is largely dependent upon restoring wetlands and associated ecosystem throughout North America (NAWMP, 2008).

In order to effectively mitigate wetland loss, countries all over the world are dedicated to conservation and restoration efforts by broadly participating in a number of the above discussed international agreements.

The United States is one of the contracting countries to the Ramsar Convention and has already designated 22 sites for the List of Wetlands of International Importance. The United States National Ramsar Committee (USNRC) is the organization formed in the U.S. to promote and advise wise and sustainable use of domestic and international wetlands (USNRC, 2008). As one of the parties signing the NAWMP, the United States has agreed to restore valuable waterfowl resources and, so far, has developed 15 habitat joint ventures over its landscape (DUC, 2008).

The European Community has also taken decisive steps to fulfill its commitments in Ramsar and CBD and to meet the target defined by the heads of state and government to halt biodiversity loss by 2010. The first Ramsar sites designated in the UK were in 1976 and many more have been designated since then. At this time,



there are 166 sites included in the List of Wetlands of International Importance (Ramsar, 2009b). In June 1994, the UK ratified the CBD and has since demonstrated its strong commitment to the Convention's objectives. It has sought to ensure that in pursuing objectives for conserving biodiversity that is regard for wetlands issues, but also that there is an appropriate interchange of common sources of data and expertise, and minimal duplication of effort (CBD, 2008b).

Canada has committed itself to extensive international treaties to implement wetland conservation activities. Canada participated in Ramsar Convention on May 15, 1981 and currently has 37 sites designated as Wetlands of International Importance under the Convention, with a surface area of 13,066,675 hectares (Ramsar, 2009a). The *United Nations Convention on Biological Diversity* commits Canada to conserving biodiversity and recognizes wetland conservation as integral to that goal (Farnese and Belcher, 2006). In April 1998, Canada signed the Kyoto Protocol and formally ratified it four years later in December 2002, agreeing to reduce GHG emissions by 6 percent below 1990 levels by the commitment period from 2008 to 2012 (Climate Action Network Canada, 2004). Wetland conserves important carbon sinks to meet Kyoto Protocol requirements. By signing the NAWMP, Canada pledged to conserve 2 million hectares of wetland habitat and effectively rehabilitated or restored 685 thousand hectares through the 1990s (Southam and Curran, 1996).

### ***2.3.3 Regional Wetland Policies***

Many governments have invested significant time and effort into the mitigation and prevention of the environmental costs associated with agricultural development. The value of wetlands for the public have led to establishment of various federal, provincial and territorial wetland conservation policies and practices to both protect limited wetland resource and balance the private and public interests in wetlands. This section provides a general overview of the existing wetlands programs within Canada. An overview of policies in the US and EU is also developed to

construct the full picture of wetland conservation state over the world. These two regions have been chosen because of their important role in driving wetland protection activities in the world and their similarity with Canada as developed country.

### **2.3.3.1 United States**

An important federal government program in the United States for wetlands protection is known as the Section 404 permit program. It was created in 1972 when Congress passed P.L. 92-500, making extensive amendments to the Federal Water Pollution Control Act (now referred to as the Clean Water Act (CWA)) (Carriker, 1994). It “governs the placement of dredged or fill material into wetlands and other waters of the United States” (NRCS, 2008). The primary goal of the CWA was to *“eliminate the discharge of pollution into lakes and rivers, as well as to improve the quality and safety of bodies of water for recreational purposes”* (Carriker, 1994). The basis for the federal regulatory programs for wetlands can be found in Section 301 of the CWA which makes it unlawful to discharge any pollutant into the waters of the United States except pursuant to the standard-setting and permitting provisions of the Act (Carriker, 1994).

The Swampbuster provision of the 1985 Food Security Act is an important federal wetland protection policy that intends to reduce the rate of wetland conversion (Heimlich, 1998). Its provision makes a farm operator ineligible for price support payments, farm storage facility loans, crop insurance, disaster payments, and insured or guaranteed loans for any year in which an annual crop was planted on converted wetlands (Anderson and Magleby, 1997). Results from several studies (Danielson, 1989, Heimlich et al. 1986, Kramer et al. 1993; as cited in Heimlich, 1998) have shown that the effect of Swampbuster to reduce wetland conversion after 1985 has been significant. Despite this, there are intensive debates about the severity of the Swampbuster penalties and its effectiveness in returning wetland stocks to the optimum level by prevention rather than compensation mechanisms (Heimlich, 1998;

Anderson and Magleby, 1997).

Although avoidance and minimization policies are crucial to protect wetlands, wetland compensation programs have become important as well in the last decade. “No-net-loss” is a federal and state policy goal that was first set out during President George H.W. Bush’s 1988 presidential campaign and announced as an administration policy at an EPA press conference in January 1989 (Sibbing, 2008). The purpose of this policy is to protect wetlands wherever possible and offset wetlands that have been converted to other uses through restoration and creation of replacement wetlands to make up for unavoidable wetland conversion, thereby maintaining or increasing the total wetland resource base (ERS, 1998). The goal of the program not only applies to wetland coverage areas within the country but also to the functions and values of those wetlands (Sibbing, 2008). This policy was embraced and expanded by President Bill Clinton in his administration’s Clean Water Action Plan, the goal of which was to attain a net increase of wetland of 100,000 acres per year by 2005. President George W. Bush’s administration also embraced the goal of no-net-loss of wetlands and made efforts to ensure a net gain in wetland acreage (Sibbing, 2008).

One of the more specific agricultural programs that has affected wetland restoration is the Wetland Reserve Program (WRP). This is a voluntary program that was first implemented in the early 1990s with an objective of retiring and restoring wetlands that had been converted to cropland by providing cost share assistance and long term (30 year) or permanent easements (Lambert et al. 2006). The WRP was mandated by Section 1237 of the Food Security Act of 1985 (P.L. 99-198), as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (P.L. 101-624) and the Federal Agriculture Improvement and Reform Act of 1996 (P.L. 104-127) to assist in protecting and enhancing wetlands while enabling landowners to retain land ownership and the rights to recreational uses, such as hunting and fishing (NRCS Farm Bill 2002, 2007). WRP participants could benefit by receiving financial and technical assistance in return for restoring, protecting and enhancing wetland functions and values, seeing a reduction in problems associated with farming potentially difficult

areas, and having incentives to develop wildlife and recreational opportunities on their land (NRCS Farm Bill 2002, 2007).

In general, various wetland policies have evolved over the United States' history. Wetland drainage was first encouraged during the period of settlement and national expansion which resulted in great loss in wetland resources. However, since the 1970's, wetland preservation was gradually accepted and conservation activities were developed. With the adoption of the "no-net-loss" goal, both conservation and restoration programs were established to achieve no overall net loss of wetlands and the effectiveness has proved to be significant.

#### **2.3.3.2 European Union and United Kingdom**

Wetlands were one of the very first nature conservation subjects put forward for European policy consideration. The *Natura 2000* network is the center piece of EU biodiversity policy and was established to assure the long-term survival of Europe's most valuable and threatened species and habitats (European Commission, 2007). In 2000, the wetlands' communication was overtaken by the *Water Framework Directive* (WFD) which is the most substantial piece of EU water legislation thus far and aims to overcome the fragmentation of European water policy. It requires all inland and coastal waters to reach good chemical and ecological status by 2015 (European Commission, 2007). *LIFE*, launched in 1992, is the EU's financial instrument that supports environmental and natural conservation projects, which at this time has already co-financed over 120 projects that are related to wetlands. Most projects of this program give support to the Ramsar Convention and working together with WFD to achieve the goal of improving the quality of water and ecosystem (European Commission, 2007).

Each of the EU member countries has developed a different set of policies and programs to address wetland issues. As a result, a comprehensive examination of EU policies is beyond the scope of this study. However, the United Kingdom represents a

reasonable case of EU wetland policy due to its long history and large impact in the EU. Like the U.S. wetland conservation policy, the UK also uses a combination of voluntary subsidized programs and regulatory programs to achieve environmental goals. In England, the Countryside Stewardship Scheme which operates under the England Rural Development Program (ERDP) makes payments to farmers and other landowners to enhance and conserve wildlife, landscape and the historic features of the countryside (WWT, 2008). Landowners involved in the scheme will return the land to wetlands by widening ditches and creating new ponds. They also established areas to provide wild bird habitats containing pollen and nectar, making the land an ideal habitat for other species of birds as well as a range of other wildlife (WWT, 2008). Scotland, which contains approximately two-thirds of the remaining wetlands in the UK, primarily addresses wetland loss by combined efforts of the Scottish Raised Bog Partnership to restore wetlands over 1000 ha across 11 sites in UK's remaining raised bogs, through activities such as removal of non native forest plantations and clearance of encroaching scrub (European Commission, 2007). The Wildlife and Countryside Act, which was established in 1981 and amended in 1991, is a regulatory Act that refers to the treatment and management of protected species. The Act prohibits interference with places used for protected species' shelter or protection or intentionally disturbing animals occupying such places like wetlands (WWT, 2008).

#### **2.3.3.3 Canada**

Although Canada is home to one quarter of the world's wetlands (National Wetlands Working Group, 1988), there is no single government organization to develop and implement wetland policies applicable to all jurisdictions. Wetland conservation is a shared federal, provincial and territorial responsibility. The federal government is a major part of the solution and directly manages about 29 percent of the wetlands in Canada, specifically those located on federal lands and waters, particularly in the northern territories. These include national parks, community

pastures, ports and harbour lands, wildlife areas and a wide range of other crown land holdings (Lynch-Stewart et al. 1996; Rubec and Hanson, 2008). The federal government is fundamentally acting as a leader and has promised to assist national efforts in wetland protection by providing models, knowledge, tools and expertise (Government of Canada, 1991). The balance of policy aimed at wetland conservation and management are primarily the responsibility of provincial governments and private landowners. All levels of governments work as partners and jointly implement many wetland management activities (Rubec and Hanson, 2008).

The most important federal level conservation policy to address wetland development is the *Federal Policy on Wetland Conservation* (FPWC) which was published in 1991. This national policy recognized that wetlands are among Canada's most threatened ecosystems. It also commits all federal departments to a no-net-loss of wetland functions on all federal lands and waters where wetland loss has reached critical levels or when a wetland is designated as important. The FPWC describes a number of goals that are consistent with Canada's obligation under Ramsar and also outlines that consultations with the Canadian public indicated a high level of support for wetland conservation efforts (Austen and Hanson, 2007). Most goals of wetland preservation and degradation minimization were achieved during the immediate years following FPWC adoption. However, as FPWC is a federal policy that only directs wetlands on federal land, its influence on wetland conservation located in privately-owned land is very limited (Cuddington, 2008). In addition, wetland restoration and enhancement would be a more important and meaningful step, despite the high level of support for wetland conservation (Rubec and Hanson, 2008). A more efficient cost-effective mechanism is desirable to determine compensation area requirements so as to better replace lost wetlands and riparian functions. However, currently there is no formula or matrix to quickly calculate how much compensation area is enough for mitigation which is also the major criticism of the FPWC (Austen and Hanson, 2007; Rubec and Hanson, 2008).

The *Canadian Environmental Assessment Act* (CEAA) which was passed by

parliament in 1992 is a “legislative basis for the federal practice of environment assessment” and is one of the most important and powerful laws concerning wetlands (Canadian Environmental Assessment Agency, 2008). It provides specific procedures for environmental assessment of projects in terms of their potential environmental impact before federal authorities can approve them (Lynch-Stewart et al. 1999; Canadian Environmental Assessment Agency, 2008; Southam and Curran, 1996). Specific reference has been applied to wetlands to prevent latent harm. For example, it regulates activities likely to affect water as it flows into or out of a wetland and sets up a system of water rights acquired through the issuing of licenses (Southam and Curran, 1996). However, CEAA has little impact on wetlands within private agricultural fields in the prairie regions.

In order to help landowner’s better measure and manage the environmental risk that comes with the business of farming, the strategy used in Canadian agriculture is the execution of *Beneficial Management Practices* (BMPs). BMPs are a practice, or system of practices, designed to minimize and mitigate the impact and risk of agricultural activities on natural resources while at the same time ensuring the sustainability of natural resources used for agricultural production and maintain long term economic viability of the agricultural industry (AAFC, 2008a). *Agricultural Policy Framework* (APF), a five-year federal-provincial-territorial agreement on agriculture that came into force in 2003, enabled agricultural producers and land managers who adopt BMPs within their private landscape to receive support from the government under the *National Farm Stewardship Program* (NFSP). This program was a joint federal and provincial cost-share initiative under the Environmental chapter of APF which provides agricultural producers with technical assistance and financial incentives to facilitate the implementation of BMPs (AAFC, 2008b). The federal government usually provides financial support through APF while the provincial governments provide technical support. The purpose of the NFSP was, on one hand, to help landowners reduce environmental risk, reduce the farming impact on water and air quality, soil productivity and wild habitat; on the other hand, to reinforce public

confidence that Canadian-grown food products are being produced using environment friendly systems (Sparling and Brethour, 2007). *Environmental Farm Plans* (EFP) must be completed by producers to be eligible for BMP funding under the NFSP (Sparling and Brethour, 2007). In 2006, wetland restoration was officially accepted by Agriculture and Agri-Food Canada (AAFC) as BMPs within the APF under two specific existing BMPs (Category 21: Enhancing Wildlife Habitat and Biodiversity and Category 28: Biodiversity Enhancement Planning). This decision means that landowners who adopt BMPs and who are eligible under the NFSP will be able to take advantage of government technical assistance and funding to ensure the wetland is restored as close as possible to the original size, depth and ecological function (DUC, 2006). There are a number of BMPs that could be adopted by Canadian landowners. Statistics from the National Funding Program show that the adoption of certain BMPs vary in different agricultural regions in Canada. For the PPR, an improved cropping system involving developed tillage types and improved applications of fertilizer are more popular than other practices to be adopted by landowners (Sparling and Brethour, 2007).

#### **2.3.3.4 Saskatchewan**

In Saskatchewan, many policy measures have been developed to promote the conservation of provincial wetlands but most of these have not proven to be particularly effective in conserving wetlands. From the mid-1990's, the province of Saskatchewan established a series of both wetland policy and legislation to protect wetlands. *The Saskatchewan Wetland Policy* was adopted in 1995 which is the province of Saskatchewan's commitment to preserve wetlands. The key document *Wetland Policy Statement* promotes the sustainable management of wetlands to maintain the "numbers, diversity and productive capacity of wetlands". This policy was implemented by provincial government departments and agencies and led by the Saskatchewan Wetland Conservation Corporation. The policy focused on the



sustainable management of wetlands on public and private lands to maintain their functions and benefits, the conservation of wetlands essential to maintain critical wetland species or functions and the restoration or rehabilitation of degraded wetland ecosystems (Lynch-Stewart et al, 1999). The supplement *Guide to Saskatchewan Wetland Policy* which was issued in the same year included “next steps” concerning public awareness, wetland monitoring, land use planning guidelines and landowner encouragement to maintain wetlands. This policy is now being revised by the Saskatchewan Watershed Authority (SWA) (Rubec and Hanson, 2008).

Following the adoption of wetland policy, Saskatchewan’s *Water Management Framework* was released by the Minister of Saskatchewan Environment and Resource Management (SERM) in 1999. This document lists nine goals and sixteen objectives of water management in Saskatchewan that would be initiated over the next five years. It also outlines 58 actions that are related to protection of water resources, co-ordination of government activities and public involvement in decision making (Government of Saskatchewan, 1999). Some objectives and actions relate specifically to wetlands and associated riparian areas and commit the government to wetland conservation. However, since certain action items have been assigned to different governmental agencies to implement, actions are developed at very different rates. Some are underway while some are not initiated yet. Conflict between the two leading agencies, Sask Water and SERM, concerning placement of accountability for attaining Framework’s objectives have also contributed complexity to objective realization (CSALE, 2002).

In 2002, Saskatchewan’s *Environmental Management and Protection Act (EMPA)* was introduced with primary responsibility for all matters with respect to the environment. Although the Act considered water resource protection, it has been deemed incomplete since it does not recognize water resources located within private-owned landscape. In the Act, crown water bodies were identified as requiring a process of protection. However, crown water in Saskatchewan only refers to water bodies and watercourses owned by provincial or federal governments, privately owned

lands are not included (Rubec and Hanson, 2008). By this definition, the EMPA does not require that landowners protect private areas that do not flow into a provincial or federal watercourse such as isolated basins, sloughs and marshes. In other words, this act provides farm producers freedom to do any activities they deem appropriate with wetlands on their own land except if this causes water to affect crown waters. The potential of this policy will limit the mitigation opportunities to some extent and will prevent effective protection of wetlands and riparian zones (Thompson, 2005, as cited in Rubec and Hanson, 2008).

The Saskatchewan Watershed Authority (SWA) was established in 2002 to provide technical assistance and regulatory guidance to the agri-food industry regarding water quality protection. In 2005, the Watershed Authority adopted the *Saskatchewan Watershed Authority Act* to manage and protect water quantity and quality within the province. The management is developed through a planning model based on stakeholder involvement for broad application. Local watershed advisory committees have been established in priority watersheds across the province to guide the planning process and to identify water protection issues. The *Act* licenses on-farm wetland drainage and is responsible for issuing drainage licenses on agricultural Crown lands used by landowners under lease arrangements (Rubec and Hanson, 2008). The Authority is currently developing a draft wetland and drainage policy to provide clear expectations and direction to prevent negative downstream impacts of drainage while reducing the regulatory burden (SWA, 2007). However, despite the importance the SWA Act plays in provincial wetlands protection, it is incomplete in defining wetlands and ignores the most threatened seasonal wetlands within agricultural landscape (Cuddington, 2008).

In addition to the above regulations, other statutes applied to wetland management in Saskatchewan include the *Environment Assessment Act* which uses enforcement measures to protect specific wetlands through the granting of permits, licenses or approvals. The *Wildlife Habitat Protection Act* which preserve specific wetland habitat areas, and the *Conservation Easement Act* which use voluntary

easement agreements to facilitate environmental goods conservation while leaving the land and management to the landowner (Lynch-Stewart et al, 1999). There are a variety of wetland conservation policies existing at the provincial level, but not all of them are efficient in achieving the goals of protection as discussed. A clear understanding of the strength and weakness of these current policies is necessary and will act as guidance for better policy provision.

#### ***2.3.4 Summary of the Policy Landscape***

Across the world, it is clear that governments and their many sectors have implemented wetland policy change over their history. Direct and indirect incentives to convert wetlands for economic development, which used to be popular, were gradually eliminated in recent decades with the increasing scientific understanding of the important functions wetlands and riparian areas provide. Support for wetland conservation policies has grown in both federal and provincial scale through a variety of mechanisms including regulations, economic incentives and education. Besides those policies that directly address wetland loss, a number of complementary legislations affecting wetland conservation were also commonly adopted by governments such as wildlife management, water issues, land use planning, fisheries management and environmental protection. For Canada, due to the separation of responsibilities and limitation of federal power over provincial wetland management, federal-provincial cooperation and coordination on wetland policy is desirable to achieve efficient and effective policy implementation. All levels of government's full participation in those agreements play a critical role in their success.

## 2.4 Economic Valuation for Wetlands and Riparian Zones

### 2.4.1 Introduction

To effectively address the problem of riparian wetland loss and understand the efficiency of wetland conservation policy, the first step is to adequately evaluate the economic value of wetlands, which has been interpreted as representing the value of wetlands to society. Open market price can be adopted as one measure to carry on the valuation, but it only reflects the minimum price people would like to pay rather than extra subjective and intrinsic values (Environment Canada, 2001). To capture the full values involved in wetlands, benefits should be measured by the entire worth of the benefits to the potential buyers—that is, the full price people are willing to pay to enjoy wetland benefits, no matter if the payment is actually paid (Barbier et al. 1997).

The importance of evaluating the economic value of wetland goods and services has been summarized as follows (Barbier et al. 1997; Lambert, 2003),

a) *Wetland resources and systems are often undervalued or ignored under traditional cost-benefit analysis.* Although wetlands support an array of valuable resource output and ecological services, not all of them could be marketed. Many wetland amenity services are provided free to all individuals and no one could be excluded from enjoying, which make them very difficult to be priced through regular trading process even if they are desired. This is often explained in economic terms as the *public good* nature of environmental goods which make wetland services liable to be undervalued. A detailed discussion of *public goods* will be presented in chapter 3. As a result, when decisions are made to convert wetlands to other use, only the direct costs of conversion are calculated as the decision costs rather than the loss of those potentially significant environmental functions wetlands provide.

b) *Economic valuation is an important tool for wetland management.* Environmental functions and benefits supported by wetlands are multi-faceted and complex. Sometimes it is not easy for government decision makers to determine the

costs and benefits of measures implemented and to ensure a wise use of wetland resources. Economic valuation helps decision makers analyze the gain and loss under each decision option and investigate how these decisions would affect social welfare with changed wetland resource allocation. Effectively determining the value of a wetland system is fundamental in achieving the desired policy goal because the failure to evaluate the full benefits and costs of conversion or conservation is a major factor behind the design of inappropriate development policies.

To illustrate the role of economic valuation in wetland use and how valuation studies could be conducted in wetland management decisions, the following sections provide a general summary of the economic valuation mechanisms and techniques that are used in wetland management research and development. Market mechanisms are powerful in measuring value but only capture partial direct values (drinking water, irrigation, carbon values, etc.) and are applied to limited products and services, while non-market mechanisms are more flexible and are appropriate to determine indirect and non-market values (erosion control, biodiversity, recreational use, etc.). Choosing the appropriate approach to assign monetary value to goods and services provided by wetland and riparian zones is important to induce policy to maintain the optimum wetland allocation.

#### ***2.4.2 Market Mechanisms***

Market valuation approaches use standard economic methods to measure the economic benefits and costs for marketed environmental goods based on the quantity demanded and supplied at different prices (King and Mazzotta, 2000). This valuation method uses observed data of actual consumer preference and accepted economic techniques and therefore, is reliable in measuring people's value of goods bought and sold in the market. The following discussion highlights some specific applications and examples of market approaches used to value wetlands and the goods and services they provide.

#### **2.4.2.1 Wetland Mitigation Banking**

Wetland mitigation banking is a market mechanism that reveals values of wetlands through market exchanges. It typically involves the consolidation of many small wetland mitigation projects into a larger, potentially more ecologically valuable site and improves efficiencies in application and permitting processes (WSDE, 2008). This management method works as a companion program to the “no net loss policy” and helps reduce wetland loss due to failure of traditional mitigation and the time lag between wetland impact and compensation (Ramsar Forum, 1998; Washington Department of Ecology, 2006). Usually the mitigation for 1 hectare of lost wetland is required at ratios of 2 or 3 to 1 to ensure there is no net loss of wetland functions. While in Canada, this mitigation approach is not commonly practiced by any province (Rubec and Hanson, 2008), in 2005, it was estimated that there were at least 405 mitigation banks issued by the Environmental Law Institute (ELI) in the United States. This number represented an 85 percent increase from the total number in 2001 and a 780 percent increase from 1992 (ELI, 2008). Mitigation banks are collections of wetlands that have been created, restored, enhanced or preserved for the purpose of earning compensatory credits permitted under the federal government programs in the United States, the Section 404 or similar local wetland regulations. These compensatory mitigation credits could be owned by landowners or be sold on the market to those needing to compensate for unavoidable negative impacts to another wetland (Hansen, 2007). Credits are usually measured in terms of wetland acreage to represent the level of service it provides (Hansen, 2007).

According to information from Mclemore Mitigation Bank (the first bank in the States to develop both a wetland and stream mitigation component), the credit is calculated based on both the purchase value of the raw land and the wetlands proposed for impact (quality of wetland), which is evaluated by the Wetland Rapid Assessment Procedures (WARP) index rating from 0.0-1.0 (Mclemore Mitigation Bank, 2008). The current rate schedule for wetland credit in Alabama with transactions under 25 credits

is \$15,000/credit with the raw land value less than \$45,000/acre (\$111,150/ha). If the raw land value is greater than \$45,000/acre, the credit price will be 1/3 of the land value/acre (Mclemore Mitigation Bank, 2008). Although the credit price is highly variable across time and space, research has shown prices have been as high as \$45,000/acre (\$111,150/ha) in Florida (Bond and Pompe, 2004).

#### **2.4.2.2 Fee Hunting**

Another partially marketed service provided by wetlands and riparian zones for private landowners is the ecological support for species that are the target of fee-based hunting and fishing. Fee hunting allows land managers to sell access to their land to hunters for consumptive activities like hunting and fishing and also non-consumptive activities such as bird watching and nature tours. The promotion of commercial recreation on private wetlands creates financial incentives to landowners and encourages voluntary conservation and restoration of ecological sensitive wetland areas with limited governmental regulation involvement (Jones et al. 2001). Landowners could diversity their income through commercial hunting activities which provides a financial incentive to ensure the presence of high quality habitats on their land. Kazmierczak (2001) provides a review of estimation of the commercial hunting and fishing service values generated by an acre of wetland. Four different categories of studies were identified to present the values. From the report by Jones et al. (2001), hunting leases were revealed to be the most common payment method used for fee hunting. Annual net revenues for landowners derived from fee hunting averaged \$3.91/acre (\$9.66/ha) statewide and \$2.17/acre (\$5.36/ha) in the Gulf Coast counties. Kazmierczak's (2001) study reported the annual price of hunting and fishing services ranged from \$1.05/acre (\$2.59/ha) (blue crab in Florida) to \$663.74/acre (\$1640.14/ha) (oyster at Northumberland, Virginia). The mean and median value were \$152.28/acre (\$376.29/ha) to 8.73/acre (\$21.57/ha) each year respectively. In other countries hunting services were valued from \$16.76/acre (\$41.41/ha) to \$120.84/acre (\$298.6/ha) with

the mean and median annual values of \$54.21 (\$133.96/ha) and \$25.03/acre (\$61.85/ha) respectively (Kazmierczak, 2001).

#### **2.4.2.3 Carbon Market**

Global warming is a significant environmental problem and a challenge for human beings. Governments and international groups are looking for ways to decrease the impact of greenhouse gas (GHG) on people and are focusing on the development of the emissions trading markets such as carbon markets. Wetlands, which act as natural carbon reservoirs, present an essential opportunity for GHG offset and carbon trading. Storage of carbon in wetlands and marketing carbon credits, as a viable market mechanism tool, helps promote sustainable environmental development and provide additional income for private landowners. Antle and Mooney (2001) in evaluating issues that arise in designing policies to increase carbon sequestration in agricultural soils showed that policies based on payments per-tonne of carbon sequestered are more efficient than those based on per-hectare payments for changes in production practices. According to Brethour and Klimas (2008), based on the *Alberta Climate Change and Emissions Management Act*, facilities that produce more than 100,000 tonnes of greenhouse gases annually should reduce their emissions by 12 percent by January 1st, 2008. This reduction could be achieved either by paying into the Climate Change and Emissions Management Technology Fund at \$15/tonne of emissions over the target or by purchasing recognized emissions reduction credits that are currently selling from \$6 to \$8/tonne. Statistics from the Chicago Climate Exchange (CCE) (the world's first active voluntary, legally binding integrated trading system) indicate that the price accepted by the trading parties during 5 months (Jan. 2008-May 2008) ranged from \$2-\$7/tonne of CO<sub>2</sub>e. The transaction cost associated with signing carbon contracts is estimated to be 15 percent commission plus an exchange rate (Brethour and Klimas, 2008). Shabman and Scodari (2004) proposed a new institutional structure (Credit Resale Program) to apply market principles to expand the quantity of and lower the



prices of credits while assuring that wetlands credit sales helps realize the no net loss goal. According to Cuddington (2008), assuming a price of \$5/tonne CO<sub>2</sub>e, utilizing private carbon markets in conjunction with publicly funded program would help reduce 20 percent of the program payments.

### ***2.4.3 Non-market Valuation Method***

Although market measures presented above provide accepted mechanisms to assign value to goods and services provided by wetlands and riparian zones, the total benefits are not fully captured. A range of social services and benefits cannot be normally traded on markets especially for the non-marketable direct use value and indirect value of wetland because such markets sometimes do not exist or are insufficiently well developed to provide good price information. Therefore, other valuation approaches have been developed to put value on these wetland goods and services. Due to the fact that the development of effective conservation policy requires an understanding of the full costs and benefits of conserving wetland function within an agricultural landscape, non-market valuation methods are appropriate to value the costs and benefits environment provides as they can reflect people's full willingness to pay. Contingent valuation methods and Hedonic pricing methods are relevant ecosystem service economic valuation techniques when market valuations do not adequately capture social value. As such, they are explicitly introduced in this section. Other ecosystem valuation methods include travel cost method, contingent choice method and productivity method etc. Examples of valuation results from previous work are also illustrated.

#### ***2.4.3.1 Hedonic Pricing***

Hedonic pricing is a non-market valuation method that has come to play a growing role in measuring ecosystem service value in recent years. As explained by Swinton et al. (2007), the hedonic method for non-market valuation relies on market

transactions for differentiated goods to determine the value of key underlying characteristics. As such, the hedonic method is an indirect valuation method in which we do not observe the value consumers have for the characteristic directly, but infer it from an observable market. This method most commonly uses variations in residential properties prices that reflect the value of local environmental quality and amenities. Since housing markets are quite efficient in responding to the information, the results from this method can represent good indicators (King and Mazzotta, 2000). However, due to complexity of the method, a large amount of data must be gathered and manipulated and a high degree of statistical expertise is required to obtain the desired model specification (King and Mazzotta, 2000). In a hedonic pricing analysis of residential properties in Maryland, Irwin (2002) concluded that compared to residential, commercial or industrial uses, open space located within 400m of a residential property increased residential prices by 2.6 percent (\$4523) if the land is preserved as private conservation land and will increase by 1.2 percent (\$2038) if the land is a public land. Tapsuwan, Ingram and Brennan (2007) found that the existence of urban wetlands helps improve sales prices of surrounding properties by analyzing data from Western Australia. The results showed that the sale price of a property increased by \$5726 with the existence of an additional wetland within 1.5 kilometers of the property. The total premium in property sale price due to wetland (50 ha) proximity was \$207 million, based on average property characteristics and medium house density. Tyrvaainen's and Miettinen's (2000) research showed that residential house prices decreased by 5.9 percent with an increase in the distance to the nearest forest area of 1 km. However, values estimated by Norris, Ahern, and Koontz (1994) are not consistent with the above studies. They applied a conventional present model to estimate the costs of wetland regulation to producers and impact of wetland regulations exposure to landowners on land prices, using hedonic approach. These result showed that increased exposure to wetland regulation had little effect on land prices.

#### **2.4.3.2 Contingent Valuation Method**

Contingent valuation method (CVM) is a survey-based valuation methodology for eliciting values people place on goods, services and amenities (Swinton et al. 2007) and is the most widely used method for estimating values when markets do not exist and revealed preference methods are not applicable. The CVM attempts to assign dollar values for the public goods by directly asking people the maximum amount the individual would be willing to pay (WTP) to obtain the non-market amenity or the minimum level of financial incentives they would be willing to accept (WTA) to compensate for a loss of an environmental amenity (King and Mazzotta, 2000). Contingent markets has been highly structured to circumvent the absence of markets for environmental goods by presenting consumers with well-defined hypothetical markets in which they have the opportunity to pay for the good in question.

However, although contingent valuation methods are commonly used, it is also the most controversial of the non-market valuation methods. The CVM has been criticized because it requires people to respond to a specific hypothetical scenario and description of the environmental service. The pre-assumption is that the respondents understand the good in question and will reveal their preferences in the contingent market just as they would in a real market. However, bias often occur due to the problem that respondents are unfamiliar with placing dollar value on a non-market product because they are confronted by a hypothetical market in which they have no means or purpose in being involved rather than an actual set of choices that are relevant to market decisions made each day. Therefore they have an insufficient knowledge basis or little past experience for stating their true value (King and Mazzotta, 2000). The fact that the contingent valuation method is based on what people say they would do, as opposed to what people are observed to do, is the source of its greatest strengths and its greatest weaknesses.

At present, there is a lack of information to quantify landowners' non-market

valuation, from the supply side of the wetland market, of the goods and services provided by wetlands within private landscape. However, this information is important since it provides essential inputs for decision making regarding wetland management in the PPR where the majority of land is private farm land. The present study will help reflect the cost of supplying wetlands and conserve them in a sustainable way.

Until now only few studies have contributed to this information. Lynch et al. (2002) developed a random utility model to examine the level of financial incentives Maryland landowners require to voluntarily establish riparian buffers on agricultural land for 15 years. Their conclusion was that higher incentive payments, part-time farming and education level had a positive influence on the respondent's WTA bid while age and the decision to continue farming for more than 15 years had a negative influence. The mean annual incentive payment indicated by respondents was \$112/acre (\$277/ha).

Some research does provide information on landowners' valuation of environmental benefits but are not directly relevant to wetland conservation. Shaikh et al. study (2007) investigated the factors affecting landowners' participation in agricultural tree plantations. The result shows that age, soil type and income are significant factors to get landowners to plant trees. The average WTA required by landowners to plant trees is estimated about \$33/acre (\$81.5/ha). Kline et al. (2000) found that the mean incentive payment to induce forest owners to forego timber harvest in riparian areas ranged from \$38/acre (\$94/ha) to \$137/acre (\$338/ha) depending on owner's objectives.

There has been substantial wetland non-market valuation focused on society's valuation of wetland from the demand side (e.g. wetland consumers) by asking about their maximum WTP to enjoy all ecosystem goods and services supported by wetlands. Do and Bennett (2007) quantified wetland non-market benefits in the Mekong River Delta (MRD) by estimating WTP for improvements in the wetland biodiversity, using environmental choice modeling. Personal interviews were conducted in three locations. The results showed that the overall WTP for the proposed wetland conservation range

was \$0 to \$2.5 per household. Older, more educated and wealthier respondents had a higher WTP. Birol et al. (2006) discovered that the mean WTP for improving wetland management attributes in Cheimaditida, Greece, was €107.56 (\$81.49) to €134.46 (\$101.86) depending on different management scenarios. Bennett et al. (1997) estimated WTP to avoid any destructive activities to Tilley swamp and The Coorong in South Australia. A one-time payment indicated by respondents was about \$45 per household (Bennett et al. 1997; as cited in Whitten, 2003).

The research reported in this thesis is intended to fill the information gap by estimating non-market values of wetlands located in private landscape using information from landowners in PPR. Specifically, it estimates WTA for restoring and maintaining wetland and riparian zones in agricultural regions. More details of the case study information are provided in Chapter 4.

## **2.5 Summary**

Wetlands and associated riparian areas have historically been considered wasteland and undergone exploitation and degradation activities. Agricultural production, acting as one of the leading threats, contributed to a major loss of wetlands. Although wetlands are neither upland in our traditional sense nor bodies of open water, they constitute some of most productive natural habitat and contribute extensively to a healthy ecosystem.

Society's awareness of the value of wetlands has grown rapidly in the last few decades and resulted in significant changes in governmental policies. Federal, provincial and territory policies have been developed to improve the health of wetlands through protection and restoration efforts.

Society values wetlands, but since most wetland benefits are freely enjoyed by all of society private owners are usually unable to benefit economically from conserving wetlands on their lands. In another words, the difference between public and private interests in protecting and converting wetlands is the key problem. This is

where market inefficiency exists and needs to be addressed using suitable wetland policies. Currently, there are several existing market management tools to assist landowners to assess partial economic benefits by trading wetland services. There are also non-market methods available to determine the value of goods and services wetlands and riparian areas offer. In order to better quantify the returns that private landowners require from wetland preservation and better achieve the goal of policies, it is important to examine the case at hand and choose the method most appropriate. The next chapter proposes a theoretical framework to explain the market failure and the wetland allocation problems.

## **CHAPTER 3 THEORETICAL FRAMEWORK**

### **3.1 Introduction**

Wetland issues have played a crucial part in agricultural and environmental debate for quite a long period of time. Because of the valuable service and benefits wetlands offer in many cases it could be argued that social welfare will be greater by maintaining or improving the quality and quantity of the remaining wetlands. However, as wetland resources are often undervalued under the current market system, as discussed in Chapter 2, they are likely to be ignored during development decisions and be converted to alternative uses. The under-supply of wetlands on the agricultural landscapes is often explained in economic terms as a market failure. At this stage, there is a role for some form of governmental intervention. This chapter presents a theoretical framework to help evaluate the costs and benefits associated with wetlands and riparian zones located on privately owned agricultural land. The theoretical framework will be applied to analyze the specific problem in the following chapter. The chapter will begin by discussing factors causing the market failure and the influence of market failure in allocating agriculture land. Then a graphical model will be developed to further illustrate the problem in the wetland demand and supply and show how policy could be used to address the inefficiency.

### **3.2 Market Failure in Agricultural Landscapes**

#### ***3.2.1 The Role of Economic Valuation***

The possibility to efficiently estimate the value of environment resources and wetlands specifically in dollar terms has received much attention in recent years. As

discussed in section 2.4.1, estimating the correct value of wetland goods and service is essential to inform wetland management and policy decisions. This process can be described as the first step of the strategy. Theoretically, this is a process to assign dollar values to goods and services provided by wetlands and riparian zones. In classical economics, the dollar value of a good is determined through the open market decided by the interaction of consumers demand and producers supply for the good. But this is not always possible for ecosystem goods and services since many such goods and services are complex and multifunctional (Barbier et al. 1997). Sometimes there is simply no direct market for these goods and services and sometimes the ecological values provided are intrinsically non-marketable (Lambert, 2003). However, such non-market benefits do represent real economic value, the quantity of money a consumer would be willing to pay, which need to be included in the decision making process (Environment Canada, 2001). The danger, if the unpriced value is not included in development decisions, is policy makers can not quantify the consequence of decisions and hence the final outcome of the policy will be biased in favor of those uses which have commercial value and many environmental resources cannot be properly conserved. If a wetland is converted without proper valuation, the result can be a significant economic loss to society, which is the opportunity cost of conversion. Such costs may include essential environmental functions as well as the biological values the wetland provides. Unfortunately, such opportunity costs are often neglected or undervalued by the public. For example, if only the direct conversion costs are valued as the cost of exploitation of an environmental resource, the decision is very likely to be conversion. However, if the costs of foregone potential environmental and biological functions are also included, the decision might change to wetland conservation since the perceived costs of conversion will be higher. Therefore economic valuation for environmental resources such as wetlands play an important role when prevailing market valuation mechanisms don't effectively represent their environmental benefits. With the help of economic valuation, the competing uses of environmental resource can be effectively compared based on the tradeoffs of resource



allocation options to provide decision makers information that can directly inform conservation policies and increase the efficiency of resources management.

### **3.2.2 Why Markets Fail**

Many of the goods and services provided by wetlands are not effectively represented by market prices that represent their value to society, and as a result, are undervalued. These costs and/or benefits are referred to as externalities (external costs and external benefits). In the presence of externalities, there is a *market failure*. In fact, market failure is relatively common in practice especially in the environmental goods and services market because of their nature. It commonly occurs when market price signals do not reflect the full or the true costs of goods and services. The failure, from a social perspective, will further result in suboptimal distribution of land use and enables allocation of goods and services in a way that does not maximize net social welfare, in other words, the allocation of resources will be inefficient. Four main inter-related explanations have been provided.

#### **(a) Public good nature**

Wetlands produce a number of benefits that could be shared by all the people. The whole community can gain welfare from the services wetland and riparian zones offer. However, many of these goods and services have *public good* characteristics which make it difficult or impossible for these goods and services to be exchanged in a market. In economics, public goods exist where the consumption of an environmental service is non-rival<sup>1</sup> and non-exclusive<sup>2</sup>. Some wetland services are non-exclusive but rival such as wetland direct market use values (Table 2.1). These services are usually open to all public but diminish as use increases (Barbier et al. 1997). There are also many benefits that are non-exclusive and non-rival such as

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<sup>1</sup> Non-rival property: The consumption of good or service by one person will not prevent others from enjoying it (Cowen, 2008).

<sup>2</sup> Non-exclusive property: People without paying for the service could also benefit from it without being excluded (Cowen, 2008).

wetland amenity values, biodiversity and ecological support. For these services, all people can enjoy the benefits simultaneously without exclusion no matter if they pay for access or not. In such situations, it would be extremely difficult to limit the use to a few individuals, prevent others' consumption and market the service. Therefore they are liable to be undervalued.

(b) Poorly-defined property rights

Another factor that can cause a market failure is the fact that many wetland goods and services do not have clearly defined property rights. Property rights represent *“one individual's ability, in expected terms, to consume the goods or the services directly or to consume it indirectly through exchange”* (Barzel, 1997; cited by Whitten, 2003). Well-defined property rights are crucial since they set a permit for individuals to benefit from possession and control and also encourage rational preservation and management. Private ownership excludes others from destruction and solves the problem of open access to a resource (Byrne, 2004). In the case of wetlands, the property rights are assigned but there is ambiguity and uncertainty in regulating some rights of wetlands especially for those located in privately owned lands (Cuddington, 2008). Debate has focused on whether government has the authority to regulate land use on privately owned land for public environmental purpose. For landowners, they purchase the land with the expectation that the land could be converted to any type of land they wish. But from a social welfare perspective even though private property rights are respected and protected under certain laws, society may need to reserve certain rights to take property for public use and the management decisions should be made in a socially acceptable way (Cuddington, 2008). Absence of clearly defined property rights for the range of goods and services provided by wetlands make it difficult or impossible for market price to correctly determine how wetlands should be used and who benefits and loses from the use of wetlands (Heimlich et al, 1998).

(c) Limited information

Poor information and limited understanding of the ecological functions provided

by wetlands and riparian zones is another potential cause of market failure. The effective transmission of information about the costs and benefits associated with wetlands and riparian areas, as well as the individual's actions based on this information, are the basic foundation of wetland markets. Accurate information can assist landowners in making rational decisions of land use and choose the most effective land allocation strategy (Whitten, 2003). However, even though a number of extension and technical assistance policies have been developed to disseminate such information, there is an incomplete understanding of the important role wetlands and riparian zones play in the whole ecosystem, as well as the understanding of how different management will influence the quality and quantity of ecosystem goods and services. To date, society has only realized the benefits of wetlands and riparian zones services after they have disappeared since only then those actual monetary costs are incurred. This lack of scientific understanding undervalues wetland benefits and contributes to market failure (Environment Canada, 2001).

#### (d) Externalities

In economics, an externality describes a situation in which the “private costs or benefits to the producers or purchasers of a good or service differs from the total social costs or benefits entailed in its production and consumption” (Johnson, 2003). In other words, an externality occurs when a party in the market does not carry all the costs or does not obtain all the benefits of the economic activity. An externality could either be positive (external benefit) or negative (external cost) (Johnson, 2003). For example, if a landowner implements wetland conservation management on private land and mitigates flooding in the area, he provides external benefits since the activity not only benefits himself but also his neighbors. On the other hand, another landowner who drains and clears wetland on the landscape imposes external costs by increasing the probability of flooding the whole neighborhood. The relationship between externalities and social values can be represented as:

$$\text{Social cost (benefit)} = \text{Private cost (benefit)} + \text{Externality effects}$$

Either positive or negative externalities would create a problem for the price mechanism and makes it difficult for effective working wetland market to maximize net benefits to society. The existence of the externalities means that one or more aspects of property rights must be incomplete because they are not clearly defined (Whitten, 2003). Compared to the general community, the benefits the individual owner receives from wetlands and riparian areas constitute only a small proportion of total benefits they provide (Environment Canada, 2001). A wetland may provide habitat for migratory birds and reduce flooding on downstream properties, but fail to generate significant benefits for its owner (Heimlich et al. 1998). For example, the biodiversity supported by wetlands create significant public benefits such as maintaining distinct biological species, providing scientific and medical research services and assuring environmental sustainability. However, the direct benefit one individual recognizes is relatively limited. When landowners cannot recognize the value of conserving wetlands but could benefit substantially from converting, they will no longer pay to conserve, which will results in market failure and wetland under-supply.

Because of the public good nature of wetlands and associated riparian areas, and related difficulty in assigning property rights, many of the values wetlands create are common assets that are free to society. No individual has to pay to enjoy those public goods and services. With limited knowledge of wetlands and widely shared resources that are already provided at no cost, there is little incentive for an individual to benefit others thus creates the externalities. As a result the market does not provide an efficient level of goods and services provided by wetlands and associated riparian areas. The consequences of a market failure in wetland and riparian area allocation within agricultural landscapes are discussed in the next section.

### ***3.2.3 Wetland Supply in Agricultural System***

A market failure results in limited wetland protection and acts as a major reason wetland resources are undersupplied from a social welfare perspective. Within North American agricultural landscapes “the vast majority of the land and therefore the wetlands within these land holdings are usually privately owned” (Farnese and Belcher, 2006). There is usually a private financial incentive for agricultural landowners to maintain the quality for their land by limiting soil erosion, avoiding excessive use of chemical inputs and taking other necessary measures to protect soil productivity. However, due to ineffective valuation of wetlands, there is usually little private incentive for landowners to invest in conservation efforts or to prevent or mitigate environmental damages that impose offsite costs (Lambert et al. 2006). Private landowners will tend to make decisions to convert wetlands to agricultural production when they find that the economic returns they receive from other uses is larger than what they would obtain if the wetlands were kept in their natural state (Heimlich et al, 1998). Therefore, as it is difficult for an individual landowner to receive direct monetary profits from the benefits that a wetland provides to others, the true value of these benefits are often not taken into account in land allocation decisions. In general, the absence of incentives for conservation will lead economically rational people to engage in environmentally damaging behavior and convert wetlands and riparian area to what was perceived to be more beneficial land uses because it confers a net personal profit, even though it imposes a net cost on society (Environment Canada, 2001). A consequence of this incomplete information is the extensive conversion of wetlands that has occurred over the last 50 plus years. Butler and Macey explain, “Since individuals in a market system respond only to the benefits and costs that they actually receive and pay for, the market system may be inadequate to deal with externalities” (Lee, 2006).

In order to counteract the problem of market failure and to reduce the difference between costs and returns for an individual’s conservation efforts, there is a

need for government to intervene to increase or maintain social welfare. Specifically, the major objective of government intervention is to encourage the increased supply of environmental goods and services through changing the land allocation to benefit society. The following section introduces a graphical model to further explain why wetland conversion actions happen and how public policies could be applied to address the problem.

### **3.3 A Graphical Model of Land Allocation**

A graphical model<sup>3</sup> is introduced in this section to present a basic framework summarizing allocation of wetlands and riparian areas. In figure 3.1, the horizontal axis represents the original stock of wetlands and riparian zones, in terms of land area, on the agricultural landscape. In this model, it is assumed that wetlands and riparian zones could be allocated either as original wetlands and riparian zones or to other uses such as agricultural production according to landowners' management decisions based on the incentives that are apparent to them. At this point, it is assumed that there is no government policy or regulation driving wetland and riparian conservation. The quantity of land converted from wetland to other uses is represented by the horizontal axis moving from the right (C) while the quantity of land still allocated to wetlands is represented by the horizontal axis moving from the left (P). The vertical axis represents an index of value of the marginal benefits provided by the land allocation in dollar value per hectare. For the purpose of the model, it is assumed that values from all land allocations can be quantified in dollars.

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<sup>3</sup> This discussion is developed and modified based on the work from Heimlich et al, 1998.

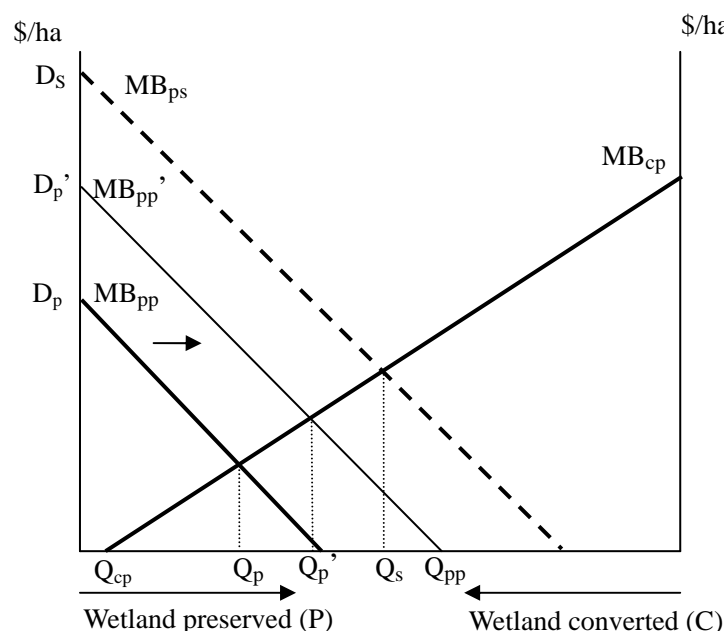


Figure 3.1 Wetland conversion and preservation

Source: Adapted from Heimlich et al. (1998)

The marginal benefits from wetland and riparian zone conversion are denoted as  $MB_{cp}$ <sup>4</sup>. This curve represents the net marginal benefits private landowners obtain by converting an incremental hectare of wetland. For the purpose of this discussion,  $MB_{cp}$  also represents the social marginal benefit from converting wetlands assuming that there are no external benefits provided by converting wetlands. This is based on the fact that although wetland conversion generates both private and social benefits, public benefits constitute only a small portion of the total benefits from wetland conversion. In reality, public benefits of conversion do exist such as increased crop production in the market and lower consumer prices. However, when wetlands are converted to produce agricultural commodities that are traded in a market, most of the benefits generated will be reflected by the price of the commodities and captured by private landowners. Compared to these private benefits, the social benefits provided by conversion are small and as a result are assumed to be zero in this model (Lee, 2006).

<sup>4</sup> The marginal net benefits are adjusted for direct conversion costs such as drainage costs but not for indirect opportunity cost such as wetland benefits foregone. Opportunity costs of wetland conversion are embodied in the marginal benefit to preservation.

$MB_{cp}$  would typically be expected to decrease as the area of wetlands and riparian zones converted increase (moving from right to left). The first unit of wetland to be converted is usually inexpensive to drain and convert to annual crop production and will provide relatively high quality and productive soil for cropping production. As a result, the marginal benefit of converting the first unit of wetland is quite high as shown in the figure 3.1. As more and more wetland area is converted to agricultural production, the land quality will decrease, providing lower productivity per hectare of land converted. The marginal benefits of converting the next hectare of wetland becomes smaller and smaller, and ultimately reaches zero because land becomes hard to drain and land quality declines. In this model, it is assumed that the  $MB_{cp}$  will intersect with the horizontal axis at  $Q_{cp}$  indicating that some quantity of wetlands will still be conserved even in the absence of a policy of wetland conservation. At each point on the  $MB_{cp}$  curve, the landowner will make a decision if an additional unit of wetland will be converted based on whether this marginal hectare provides a net benefit to them. Since benefits from conversion are usually considered as the earnings private landowner receive from cropping, if the income landowners receive from cropland is positive, conversion continues. Otherwise, conversion would be much slower. Since the remaining wetlands will cost the landowner too much to convert to crop due to either the poor quality of land or the difficulties involved in drainage, landowners will stop at the intersection point  $Q_{cp}$ , in the absence of private benefits gained through wetland conservation.

In figure 3.1, the slope of the  $MB_{cp}$  curve measures the extent marginal benefits will change as an additional unit of wetland is converted. In most cases, theoretically, this curve is relatively flatter, since wetland conversion provides more intensive agricultural or developed uses and more returns to the individual landowner. However, in practice, the shape of the slope is largely dependent on the ease to convert wetlands and riparian areas based on the different soil quality of the specific landscape. In the real world, the relationship between changes in marginal benefit and conversion wetlands might not be a linear situation as described in the figure. The marginal



benefits for the first units of wetland to be converted might not decrease due to similar characteristics these wetlands possess. With a greater area of conversion, a threshold is reached where the marginal benefits would start to decrease fairly quickly because of the possible difficulties in draining and converting.

The private demand for wetland and riparian area preservation is represented by  $MB_{pp}$ <sup>5</sup> (Figure 3.1) and represents the benefits a landowner will receive from conserving wetlands on their land. These benefits are mostly associated with on-site benefits such as personal recreational opportunities and aesthetic views of wildlife, direct monetary benefits may be available from haying, grazing, and fishing. Consistent with the discussion for  $MB_{cp}$ , the net marginal benefits for wetland conservation decrease as the area of wetlands protected increase reflecting a standard demand model (moving from left to right). When a landowner possesses no wetlands in the landscape, the first unit of wetland will usually provide significant marginal benefits such as water, views of ducks and livestock forage. Therefore, the marginal benefit of the first unit preservation is quite high. With greater areas of wetlands conserved, the incremental benefit provided declines. At the point where the  $MB_{pp}$  intersects with the horizontal axis at  $Q_{pp}$ , the marginal benefit of wetland conservation becomes negative. This could be due to factors that decrease land productivity in the presence of wetlands such as crop pests, decreased field efficiency and high water tables (Whitten, 2003). Compared to the shape of  $MB_{cp}$ ,  $MB_{pp}$  is relatively steeper since in this model, it is assumed that only limited benefits will be provided to individual landowners from wetland protection and thus marginal benefits decrease faster with more wetlands preserved.

The optimal allocation of wetlands and riparian areas from a private landowner's view is the point of land allocation where the marginal benefits from conserving wetlands equals the marginal benefits from converting wetlands. In figure 3.1 this point is represented by  $Q_p$ . At this point, the benefits landowners gain from

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<sup>5</sup> The marginal benefits are adjusted for direct costs of wetland conservation but not for indirect opportunity costs such as economic revenue from wetland conversion. Opportunity costs of wetland conservation are embodied in the marginal benefits of wetland conversion.

converting a marginal hectare of wetland is equal to the benefits available from retaining wetlands as is. If we assume foregone benefits being the costs, any further conversion activities would result in fewer benefits gained from conversion than foregone profits involved.

Due to the public good characteristic of ecosystem goods and services, protecting wetlands can provide significant social benefits, namely the benefits the individual landowners are able to specifically capture. Such social benefits constitute a large proportion of wetland amenity and could not be reflected in one individual's account, including benefits such as flora and fauna habitat preservation, climate stabilization and groundwater recharge and discharge, etc. These benefits are non-excludable and as such, once they are supplied by the landowner, all society can receive benefits from the enjoyment of these goods and services. Thereby the current market does not possess a proper mechanism for landowners to capture such social benefits. As introduced before in section 3.2, the difference between social benefits and private benefits are defined as external benefits or more generally "externalities". Adding these external benefits to private marginal benefits  $MB_{pp}$  results in the significantly higher social marginal benefit for wetland preservation  $MB_{ps}$  (the dotted line). As depicted in figure 3.1, external benefits are represented by the area between  $MB_{pp}$  and  $MB_{ps}$ . Denoted in equation,  $MB_{ps} = MB_{pp} + \text{external benefits}$ .

From society's perspective, the socially optimum allocation of the stock of wetlands is determined by the point where the social marginal benefits for preserving and converting are equal, shown by  $Q_s$ . From figure 3.1, it can be shown that point  $Q_s$  is located to the right of the private optimum ( $Q_p$ ) quantity, indicating that too few wetlands are conserved in an unfettered market. To increase social welfare, more wetland and riparian areas must be conserved with less land allocated to agricultural production. Since external social benefits are not reflected in the market and as such, landowners fail to receive adequate incentives to increase wetland conservation to social optimal levels, government policies can be used to enable the market to provide the maximum social welfare.

Governmental involvement in the form of policy measures can include, as discussed in Chapter 2, a number of instrument options from education and technical assistance, economic incentives payment to mandatory regulations and policies. Economic incentive payments have been shown to be more efficient in many applications in encouraging wetland conservation and allowing landowners the flexibility to determine participation, it is chosen to represent an environmental policy showing how to narrow the gap between private and social optimal land allocation and how the externalities could be “internalized” by applying policy tools.

For the purpose of this discussion, it is assumed that an economic incentive is now introduced by the government with the intent to address the market failure in wetland allocation. The implemented policy provides monetary compensation to landowners who agree to protect wetlands and riparian zones for a period of time on their land. It is also assumed that this is the only policy measure the government implements at this time. Prior to the implementation of the policy, private landowners are only willing to supply  $Q_p$  wetlands on their land and convert the remaining wetlands. After the policy is introduced, the marginal private benefits from protecting wetlands increase by  $D_p' - D_p$  since landowners are able to receive extra returns, in the form of incentive payments for their effort in providing wetlands goods and services. The increased returns afford landowners the incentive to provide more wetlands. As a result, the marginal benefit of wetland and riparian zones expands from  $MB_{pp}$  to  $MB_{pp}'$  along with a consequent increase in wetland preserved from  $Q_p$  to  $Q_p'$ . The higher the monetary compensation, the more marginal benefits landowners will obtain from preserving wetlands and less wetland will be converted to agricultural production. If the economic incentive payment is set exactly equal to  $D_s - D_p$  as shown in figure 3.1, conservation will move from  $Q_p$  to  $Q_s$  where optimal wetland conservation level equals the social optimal level. At this point, external benefits provided by wetland and riparian conservation would be fully captured by individuals through the incentive payment and marginal social benefits will equal marginal social costs. If the compensation payment is less than  $D_s - D_p$ , it is unlikely that socially optimal

conservation market failure could be corrected.

The model discussed above provides a general conceptual picture for understanding the allocation of land within an agricultural landscape. For individual landowners, they will stop converting wetlands when the marginal benefits of converting are equivalent to the marginal benefits of preserving. Due to the market inefficiency problem of wetlands, there exists a gap between the actual and the socially optimal allocation of land between remaining and converted wetland. To minimize the divergence, policy measures can be implemented.

### **3.4 Summary**

The non-market goods and services wetlands produce for society are important and are valued by society. Wetlands constitute an essential support system and are argued to deserve recognition and protection actions. The loss and degradation of wetlands that has occurred within agricultural landscape has been interpreted as a market failure. This market failure has been explained due to the public nature of wetlands, poorly defined property rights, limited awareness and externalities. With the purpose to address the full economic picture of wetland benefits and to enable landowners to capitalize on the social benefits wetlands produce, government intervention is often implemented. Provided that economic incentives are an effective and flexible way to encourage wetland conservation, it has been focused in this chapter to explore the function of policy in achieving social optimum land distribution.

In order to correctly value the net external benefits and estimate efficient economic incentives to reach the socially optimal level of wetland conservation, non-market valuation techniques described in next chapter are applied. In economics, measurement could be accomplished by estimating landowner's willingness to accept (WTA), which is a mechanism to quantify individual's utility in terms of their stated preference. More information concerning WTA use in deciding economic incentives is

presented in chapter 4.

## **CHAPTER 4 RESEARCH MATERIALS AND METHODS**

### **4.1 Introduction**

The agricultural region of southern Saskatchewan is where the conversion and destruction of wetlands and the decrease of the provision of wetland goods and services represents a significant problem. Two study sites were selected within this area for more extensive analysis of wetland conservation activities. Applying the theoretical framework presented in Chapter 3, this chapter will develop a specific case study to assess the economic incentive payment required to encourage landowners to adopt wetland conservation management on agricultural land. A willingness to accept (WTA) method is applied in the current research to achieve this goal. The targeted study area is described in the next section, followed by a discussion of the survey methods and procedures. A mathematical framework for assessing an individual landowner's utility is then introduced to represent landowner's choice of conserving wetland habitat in return for financial assistance, based on random utility maximization theory. Finally the chapter concludes with a description of the research survey.

### **4.2 Description of Wetlands in Saskatchewan**

#### ***4.2.1 Geographical Information***

The province of Saskatchewan is well known for its flat southern plain which was glaciated during the last ice age. Over 50 percent of the province is covered by forest and approximately 30 percent of the land is cultivated for agricultural use and over 12 percent is covered with water (Canada facts, 2008). Across the province, the distribution, size and the shape of wetlands have largely been determined by the characteristics of the glacial landscape (Huel, 2000).

Saskatchewan has been classified into eleven natural ecoregions from north to south (Figure 4.1). A variety of soil types in the southern half of the province, primarily brown, dark brown and black, corresponding to the mixed grassland, moist mixed grassland, and aspen parkland ecoregions, respectively, are highly suitable to the production of various food and fibre commodities (Huel, 2000).

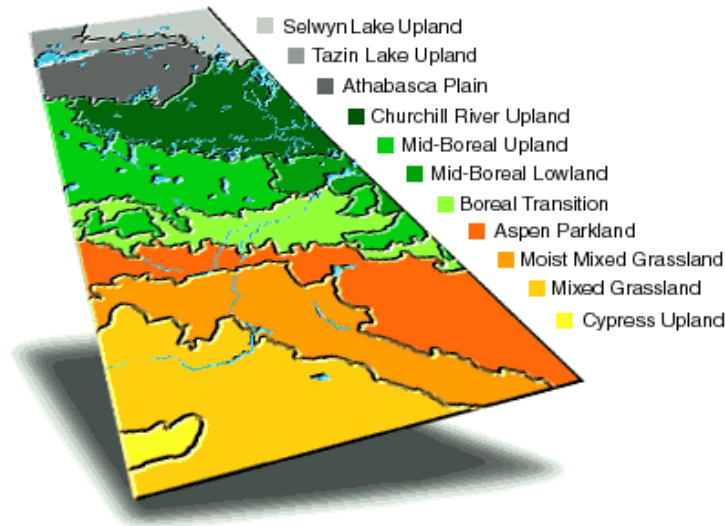


Figure 4.1: Saskatchewan ecoregions map

Source: Virtual Saskatchewan (2008)

The climate of southern Saskatchewan is characterized by extremes in temperature from cold winters to hot, dry summers. The amount of rainfall ranges from 30 cm (about 12 in) to 43 cm (17 in), with the driest part being in the southwest and far north (Saskschools, 2008). The combination of climate and the geographic condition of the province combine to make this area one of the most productive waterfowl habitat regions in North America. Over 150 species of birds and animals are known to make their home in Saskatchewan wetlands (Huel, 2000). Wetlands such as lakes, flats and marsh habitats, along with upland nesting habitats represent critical natural resources for the success of migratory bird species.

### ***4.2.2 Saskatchewan Wetland Status***

PPR wetlands are concentrated in the southern portions of the three prairie provinces in Canada - Alberta, Saskatchewan, and Manitoba (Natural Resource Canada, 2007). These wetland regions usually suffer from low precipitation and long periods of drought. In general, PPR wetlands are relatively small in size. Several types of wetlands are recognized based on Saskatchewan climate conditions and vegetation (Huel, 2000; Mitra et al. 2003; Schuyt and Brander, 2004). For the present study, wetlands are divided into two categories, permanent and seasonal wetlands, distinguished primarily by the length of time that these basins hold water into the summer following the spring runoff. Permanent wetlands are defined as any water body that typically contains open water through the summer in most years, while seasonal wetlands hold water only into the late spring or early summer in most years.

In Saskatchewan, wetlands not only support a variety of plant species but function as part of a complex and intricate hydrological system (Huel, 2000). Wetlands and surrounding plant communities are important links between atmospheric, surface and groundwater movements. The cumulative effect of wetlands on climate is crucial in determining the amount of precipitation in Saskatchewan (Huel, 2000).

## **4.3 Research Procedures and Methods**

### ***4.3.1 Study Area***

The current research is part of larger interdisciplinary research project directed by Ducks Unlimited Canada in conjunction with the Advancing Canadian Agriculture and Agri-Food (ACAAF). The two study sites targeted for this research were selected for the larger project to meet its objective biophysical data are Statistics Canada Census Agriculture Region (CAR) 8B and 3AN (Figure 4.2). Both of the study areas lie within prairie ecozones and fall within the PPR of North America.



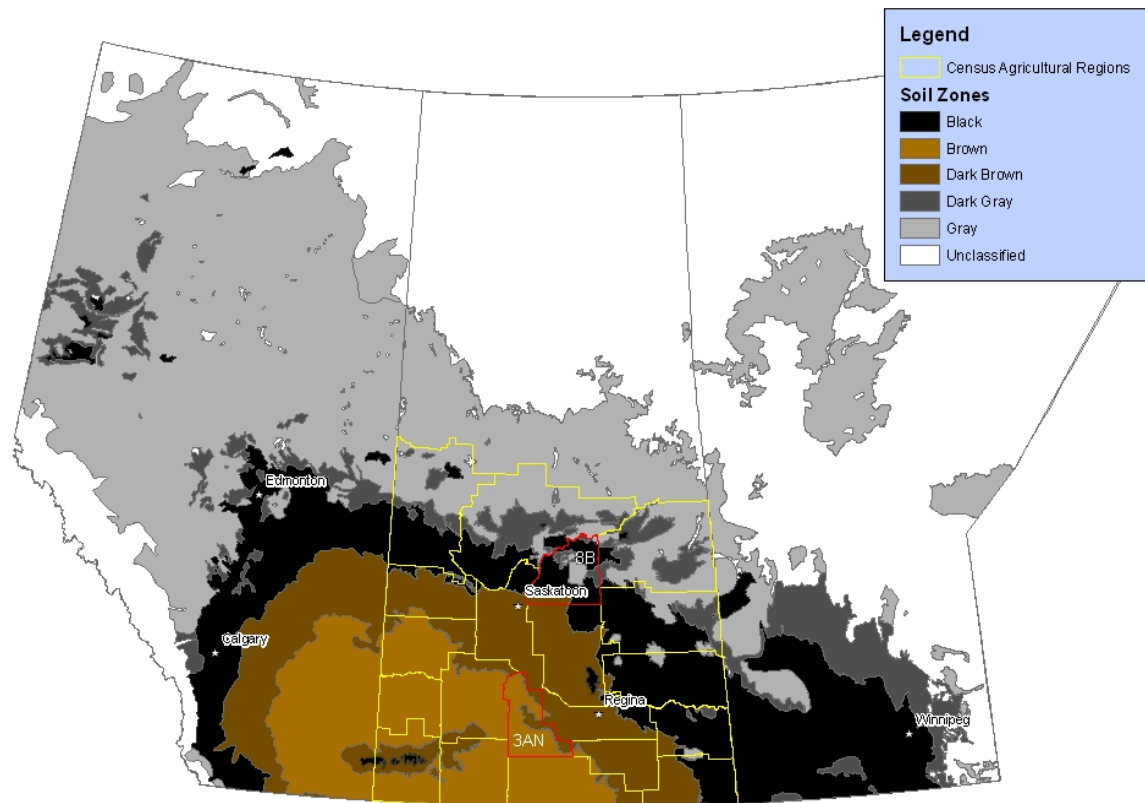


Figure 4.2 The study regions in relation to the soil zones

Source: CRERL (2009)

The first study area is located in the Statistics Canada Census Agriculture Region 8B (figure 4.2). The total cultivated land base in this agricultural region (Figure 4.3) is approximately 1 million hectares and cropping area is about 774,790 hectares (Statistics Canada, 2006a). This agricultural region falls within three ecoregions: the Aspen Parkland Ecoregion, the Moist Mixed grassland Ecoregion and the Boreal Transition Ecoregion. Dark brown and black soil are the two major soil types in this study region which have high levels of organic matter at the surface and are thus dark or black in color (The Encyclopedia of Saskatchewan, 2008). The lowland and plains of this area have been mostly cultivated for agriculture production. Native vegetation of this area was characterized by mid-grass species and shrubs. The dominant vegetations around wetlands are sedges, rushes and trees such as trembling aspen,

balsam poplar and willow (Hogan and Conly, 2002). The climate here is extreme. Temperatures extremes vary greatly between seasons, ranging from +40°C in summer to -50°C in winter. The average daily temperature in July is 18°C while the average daily temperature in January is -17°C (Environment Canada, 2009). The majority of the precipitation is summer rainfall between May and September, with the peak in July.

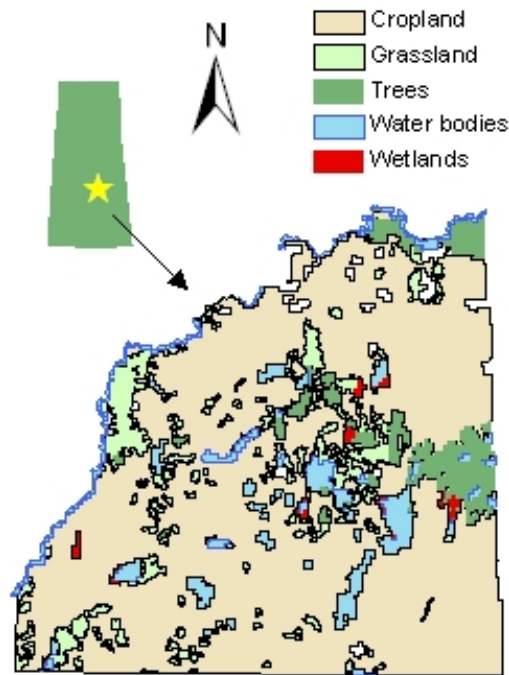


Figure 4.3 CAR 8B

The second area, CAR 3AN, is situated in the brown soil zone (Figure 4.2). Total area of farm land within this CAR is about 0.8 million hectares with half of the area used for annual crop production (Figure 4.4). This study area falls within the Mixed Grassland Ecoregion which is found in the southwest part of the province. This is the driest ecoregion in the province with a mixture of mid-grass species such as wheat grasses and short-grasses such as blue gramma (The Encyclopedia of Saskatchewan, 2008). The relatively dry climate and low precipitation has imposed severe limitations to agricultural production. Extreme temperatures range from +42°C in summer to -47°C in winter. The average daily temperature in July is 19°C while the average daily temperature in January is -13°C (Environment Canada, 2009). Water

conservation management practices such as summerfallow are more commonly practiced in this area. However, many small wetland areas or sloughs occur throughout this region, although the density, permanence and characteristics of the wetlands are different than in the more humid landscape in CAR 8B.

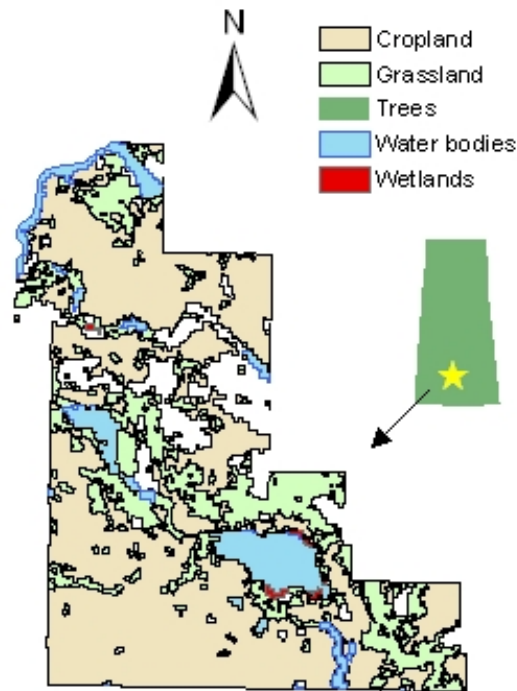


Figure 4.4 CAR 3AN

A comparison of demographic and physical characteristics of the two study areas is summarized in table 4.1. Different soil characteristics, temperature and climate account for distinct vegetation composition and farming management regimes within the two areas. With greater precipitation (and lower evapotranspiration), water is less limiting in CAR 8B resulting in higher biomass and more diverse vegetation species. These wetter conditions also result in greater amount of wetlands and riparian areas found in 8B than in 3AN.

Table 4.1. Demographic and physical characteristics of the two study areas

Study area	Population <sup>a</sup>		Area (ha) <sup>a</sup>		Rainfall (cm/yr) <sup>b</sup>	Soil type	Land use
	Farm	Total	Farm	Total			
8B	3,135	23,657	1,009,356	1,092,400	42	Dark brown	Forestry
						Black soils	Grassland
							Farmland
3AN	1,435	5,240	806,871	933,000	35.2	Brown soils	Grassland
							Farmland

<sup>a</sup> Statistics Canada (2006a)

<sup>b</sup> Environment Canada (2009)

The two study areas are chosen to reflect variations of wetland landscape in agricultural region within the PPR in Saskatchewan. These study sites were selected because of their similar management history and extensive database (vegetation, land use, GHG flux etc.) within two regions. Both sites were felt to be relatively representative in reflecting Saskatchewan land use. In addition, analysis developed for these two soil type and climate regions enable the results to be interpreted for the broader prairie landscape. The next section will provide a description of the research methods applied to develop wetland management plan adoption analysis.

### ***4.3.2 Research Method***

#### ***4.3.2.1 Incentive-Based Policy***

Among the wide range of policy instrument options discussed in the previous chapter, economic incentive programs are often considered more effective than educational assistance and more flexible than regulation to meet environmental goals. Under incentive programs, landowners are free to compare the incentives they receive and the costs they would incur due to the changed management practice. This process on one side assists landowners to choose the most profitable private management plan before participation and, on the other side, directs agri-environmental activities to the most cost-effective farms (Cuddington, 2008).

In this study, a proposed economic incentive program is aimed at conserving and restoring wetlands and riparian zones in Western Canada. The proposed program provides financial payment as the primary incentive to induce conservation activities while technical and educational assistance is also provided through the program to help offset some of the transaction costs imposed on landowners who adopt the conservation program. In order to ensure wetland and riparian area conservation and to be consistent with existing conservation programs (U.S. Conservation Reserves Program (CRP), Wetlands Reserve Program (WRP), and Canadian Greencover Program), a 10-year commitment period is proposed in this research.

#### **4.3.2.2 Contingent Valuation Method**

In developing effective programs that provide financial incentives to landowners to adopt conservation management, it is important to effectively measure the amount of incentives that are required to meet ecological objectives. This information will help improve conservation participation rates while ensuring an efficient use of limited public funding. However, quantifying the optimal value of the incentive can be extremely difficult. Both private and social benefits and costs associated with use and non-use values must be properly estimated. According to Shaikh et al. (2007), the difficulty and uncertainty in determining the incentives for wetland conservation could be summarized as follows; 1) the costs of providing wetland and riparian zones within agricultural fields are unclear due to the geological and local precipitation difference; 2) landowners will worry about the risk that results from the reduced capacity to produce agricultural commodities and decreased land use flexibility; 3) landowners' preference and knowledge of environment protection activities are heterogeneous.

To assess the cost of landowner adoption of conservation management of agricultural wetlands and to quantify the required level of payment required to encourage adoption, non-market approaches can be used. Foregone profit generated

from agricultural production is considered one way to represent landowners' cost of conservation. However, it is an incomplete measure. Although the foregone profit from producing agricultural commodities constitutes an important part of the cost, the total financial compensation required by the landowner might be influenced by many other factors such as the opportunity cost (land rent), personal preference, the difficulty of managing wetlands or retirement status. Furthermore, economic incentive amounts could also be affected by landowners' risk attitude, length of contract period and different transaction costs expected (Shaikh et al. 2007).

The most common approach presently applied to value wetland benefits including both use and non-use values is the Contingent Valuation Method. This approach has been used numerous times in related studies to reflect the respondents' preference for non-market goods. CVM is valuable in this context since it reveals landowners' personal preference for increments or decrements of unpriced wetland services by using a contingent market (King and Mazzotta, 2000). The method is used because some wetland amenities that need to be valued are assumed to leave no behavioral trail for economists to employ, in other words, landowners' willingness for wetland goods and services are unable to be discovered through their purchases or by their behavior. An appropriate option to estimate its value is by exploring their stated preference. In current research, landowners were asked explicitly about their WTA compensation for participation in a wetland and riparian conservation program. This method is able to incorporate both wetland non-market values and landowners' risk attitudes into the financial compensation amount.

Although CVM has been largely accepted and applied, there still exist considerable criticisms as to whether it sufficiently measures people's valuation for public goods and services, as discussed in section 2.4.3. In order to collect useful data and provide meaningful results, proper design of the contingent device (survey) and effective pre-tests are needed to minimize biases and to make WTA an appropriate tool to measure wetland values. Some key issues in the construction of accurate and effective survey instruments have been identified by previous CVM literatures

(Hanemann, 1994; King and Mazzotta, 2000): a) consider people's familiarity with the goods or services before designing the survey; b) provide an accurate and clear description of the environmental services associated with the event, program, payment policy and length of contract etc; c) ask questions in a close-ended format<sup>6</sup> rather than open-ended format; d) avoid bringing respondents a high-pressure interview situation; e) provide definitions of important terms to eliminate any possible confusion that may cause respondents to inappropriately value the goods or services. In the present survey, all of these issues were considered and techniques were applied in the survey designing and data collecting process. Specific survey implementation details are provided in section 4.3.3.

#### **4.3.2.3 A Model Framework for the Adoption Behavior of Landowner**

When a landowner is confronted with the decision to adopt a wetland conservation program with economic payment, as questioned in the survey, he is assumed to choose the action that maximizes his utility. A common approach used to develop this model is based on the discrete choice random utility maximization (RUM) theory (Hanemann, 1984; Train, 2003). Discrete choice modeling usually involves choices between two or more discrete alternatives to quantify the impact of variations on the choice by using statistical models. The discrete choice format is used in this study to capture landowner's decisions in terms of the opportunity to provide particular wetland conservation actions on the agriculture land and to estimate how the various attributes' influence the landowners' decisions. RUM is the theory that is widely adopted in the discrete choice model for application. It is developed based on the assumption that the landowner knows their utility function with certainty and is a well-informed decision maker capable of choosing the alternative that provides the greatest utility. Rather than using the individual's maximum profit function to explore

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<sup>6</sup> Questions could be asked either in open-ended format or close-ended format. In open-ended format, respondents are asked to make up their own WTP or WTA for the environmental improvement. While in a close-ended format, a specific amount is usually provided for the WTP and WTA question and the participants are only allowed to choose from a pre-existing set of discrete answers such as yes or no.

the effects of various incentives to induce conservation activities, the discrete choice model estimates by comparing the extent of landowners' willingness to preserve wetlands with offered incentives.

Now it is assumed that a landowner is willing to take steps to conserve wetlands and riparian zones on the land under the condition that the utility provided by participating in the conservation actions is at least as great as the next best alternative land allocation. It is also assumed that this landowner's expected direct utility can be represented as  $u(m, y, s)$ , where  $m$  indicates the conservation choice.  $m=0$  if the landowner refuses the policy incentive offer and keeps converting wetlands and associated riparian zones to agricultural production, and  $m=1$  if the landowner accepts the offer and agrees to conserve wetlands within the agricultural landscape.  $y$  represents the individual's income and  $s$  is a vector to measure those additional uncertain attributes that may have an effect on landowner's acceptance choice such as personal characteristics, individual preference and land quality. Based on Hanemann's theory (1984), the outcome of the decision is probabilistic and includes some unobservable components that are hard for economic researchers to account for. The attributes the decision maker has in determining the alternative choices is only partly observed. Therefore we assume that the individual's utility function  $u(m, y, s)$  could be specified as an indirect utility function  $v(m, y, s)$  and an additional independent and identically distributed (iid) error term  $\varepsilon_m$  with zero mean, capturing factors that have impacts on  $u$  but not included in  $v$ , such that

$$u(m, y, s) = v(m, y, s) + \varepsilon_m \quad (1)$$

Now assuming an economic incentive payment,  $P$  is introduced to encourage wetland conservation. Utility maximization theory reflects the condition that the landowner knows with certainty with which land allocation choice maximize utility. The individual will be willing to conserve wetlands with encouragement of payment  $P$  if he is at least not worse off with the incentives than without such as to keep the utility



level unchanged. The impacts of this economic payment  $P$  on the landowner could be reflected as (Hanemann, 1984; Kinsbury and Boggess, 1999; Cooper and Keim, 1996):

$$v(0, y, s) + \varepsilon_0 \leq v(1, y + P, s) + \varepsilon_1 \quad (2)$$

The minimum required incentive payment is determined by the amount that will make the landowner indifferent between accepting the bid and conserving the wetland, and maintaining the status quo. When  $v_0 + \varepsilon_0 < v_1 + \varepsilon_1$ , the wetland conservation management will be accepted by the landowner. When  $v_0 + \varepsilon_0 = v_1 + \varepsilon_1$ , the landowner is indifferent between the choices. Otherwise landowners will reject the policy offer.

If we further assume the functional form of  $v$  is

$$v(m, y, s) = s' \beta_m + \alpha y (\alpha > 0) \quad m = 0, 1 \quad (3)$$

then the landowners' decision to conserve wetlands (2) could be rewritten as:

$$\begin{aligned} s' \beta_0 + \alpha y + \varepsilon_0 &\leq s' \beta_1 + \alpha(y + P) + \varepsilon_1 \\ \Rightarrow \varepsilon_0 - \varepsilon_1 &\leq s' \beta_1 - s' \beta_0 + \alpha P \end{aligned} \quad (4)$$

where  $s$  is a vector of various attributes that affect the landowners' choice,  $\beta$  is the coefficient of the attributes,  $P$  is the offered economic incentives and  $\alpha$  is the coefficient of  $P$ .

Since the individual's utility is a random variable, the probability form would be more analytically convenient to reflect landowners' decision to adopt the conservation activities. Usually the probability of 0.5 is set to stand for the indifference response in order to solve for the median incentive payment  $P$  (Kinsbury and Boggess 1999). Following Hanemann (1984) and Kinsbury and Boggess (1999), this probability form of equation (2) can be expressed as:

$$\begin{aligned} \text{prob}(m=1) &= \text{prob}(v(0, y, s) + \varepsilon_0 \leq v(1, y + P, s) + \varepsilon_1) \\ &= \text{prob}(v_0 + \varepsilon_0 \leq v_1 + \varepsilon_1) \end{aligned}$$

$$= \text{prob}(\varepsilon_0 - \varepsilon_1 \leq v_1 - v_0) = F_{\Delta\varepsilon}(\Delta v) \quad (5)$$

$$\text{prob}(m = 0) = 1 - \text{prob}(m = 1)$$

where  $v_1 - v_0 = \Delta v = s' \beta_1 - s' \beta_0 + \alpha P$ , and  $F_{\Delta\varepsilon}(\Delta v)$  is a cumulative distribution function for each random term  $\varepsilon_0 - \varepsilon_1$  evaluated at the observed quantity  $v_1 - v_0$  (Train, 2003).

Different assumptions about the distribution of the unobserved part of utility ( $\Delta\varepsilon$ ) result in different discrete choice models. The two most popular probability density functions used for estimating landowner's propensity to participate in the conservation alternatives are the probit and logit models. If the normal distribution is assumed, the model is called the probit model while if the distribution is logistic, the model is called the logit model. It should be noted that while a linear probability model is another alternative approach, the significant shortcoming of this model include its heteroscedasticity of error term  $\varepsilon$  and it does not constrain the probability of landowners' choice decision between 0 and 1 which is required by the probability theory. In the present research,  $F$  is assumed to be standard normal distribution and yields the probit model<sup>7</sup>.

An individual landowner's decision to participate in the program, as can be seen from discussion, is the outcome of a utility-maximizing plan over two alternatives. For the conservation program to be implemented in an area, it needs to take into account a large group of landowners' choices together to increase supply of wetland benefits supply. Each landowner decides on a self-interested course of action in view of individual circumstances and objectives. Therefore, the socially optimal allocation of wetlands requires the simultaneous compatibility of the disparate plans of a large

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<sup>7</sup> The probability of  $m=1$  can be computed from the standard normal CDF as

$$\text{prob}(m = 1) = \int_{-\infty}^{\Delta v} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt = \int_{-\infty}^{s' \beta^1 - s' \beta^0 + \alpha P} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt$$

Since  $\Delta v = s' \beta_1 - s' \beta_0 + \alpha P$  is generated directly from the utility model given, it is consistent with the theory of maximization.

number of different landowners (Jehle and Reny, 2001).

Let  $N = \{1, 2, \dots, n\}$  represent an index of the set of individual landowners and  $q_{n,m}(m, y_n, P, s_n)$  be landowner  $n$ 's nonnegative supply of wetland as a function of their conservation choice  $m$ , income  $y$ , offered economic incentives  $P$  and personal attributes  $s$ . The market supply of wetlands through the conservation program is simply the sum of all landowners' wetland supply and could be represented as

$$Q \equiv \sum_{n \in N} q_{n,m}(m, y_n, P, s_n)$$

$Q$  gives the total amount of wetlands all landowners in the market would like to conserve and supply.

### ***4.3.3 Research Implementation***

Given the above discussed methodology, the present study developed a survey instrument to examine landowners' willingness to accept the proposed wetland and riparian area management plan. In order to minimize the difficulty and to ensure survey language and format could be easily understood by respondents, terminology and scenarios were clearly interpreted, respondents were able to answer the questions as they were originally intended, and early drafts of the survey were thoroughly pilot-tested with Saskatchewan landowners to improve results.

A total of 4110 survey questionnaires were mailed out in July, 2007, to all registered farms located in two study regions--CAR 8B and 3AN--by unaddressed mail. Post cards were sent out three weeks after the first mailing as a reminder. The survey included a brief personalized cover letter explaining the purpose of the questionnaire and participation rules and a prize draw form valued CAD \$200, which was intended to help increase the effective response rate. The whole survey consisted of about 30 questions and was expected to be completed by landowners within 15 minutes (See Appendix A for a copy of the survey questionnaire).

A willingness to accept (WTA) question was included in the survey which focused on restoring and maintaining wetland and riparian zones in agricultural

regions of Western Canada. An illustration depicting an agricultural field with a riparian area was included to ensure the description of the topic was clear. This WTA question proposed a ten year wetland and riparian management program that covers landowners' costs of wetland conservation while compensating for lost agricultural production. During the ten year program contract period, it was stated that both financial and technical assistance were expected to be provided to landowners who maintain permanently vegetated riparian zones around wetland within agricultural fields. The bid compensation range for this study was selected on the basis of previous studies concerning economic incentive-based environmental program and the pilot test. Ten annual payment values were proposed ranging from \$10/acre (\$24.7/ha) to \$55/acre (\$135.9/ha), with increments of \$5. With the close-ended, format the respondent was simply asked to provide a "yes" or "no" answer to a single bid question (Appendix A Question 9)—"The program would provide farmers with an annual \$50 (for example) per acre payment based on the area that is allocated to permanent riparian vegetation. Would you accept this program payment to restore and/or maintain riparian areas around wetlands on your land?" The bid amount was randomly assigned to survey respondents in an attempt to ensure that equal responses would be returned for each value. In addition to WTA compensation for wetland conservation, the survey also elicited detailed information on landowners' personal profile, agricultural operations, landowners' opinion about functions of wetland and riparian areas and their planning of farm management. Such information was collected to assist in assessing the impact of various farm and landowner characteristics on the magnitude of the economic incentive payment required. Survey demographic results were compared with appropriate data from Canada's 2006 Census of Agriculture to evaluate how representative the survey sample was. The results are presented in the following chapter.

## **4.4 Summary**

This chapter has provided the biophysical background information of wetlands located in the province of Saskatchewan and introduced the study areas that were adopted for investigating landowners' wetland conservation decisions. In order to quantify the amount of economic incentives needed to encourage wetland conservation, landowners' decisions have been examined from a utility theoretic standpoint. If the utility landowners receive economic incentives and conserving wetlands is at least as great as the original status, they will decide to accept the program offer. If not, they will refuse the offer. WTA is applied in the exploration process as the tool to elicit individual's utility in terms of their stated preference. In the next chapter, a discussion of the survey results and an explanation of the empirical model are presented to examine the policy in encouraging wetland conservation and factors that may influence the management of wetlands with the acquired data.

## **CHAPTER 5 RESULTS AND EMPIRICAL ANALYSIS**

### **5.1 Introduction**

The previous two chapters have provided the theoretical and research background to evaluate the cost of wetland and riparian area conservation within agricultural landscapes. The aim of this chapter is to link the theoretical model to the two study areas in Saskatchewan in order to investigate the policy for efficient land allocation. The chapter analyzes the characteristics of landowners and geographical factors that may affect their participation choice. An investigation is also conducted to evaluate economic incentives as a policy tool to induce landowners to maintain wetland and riparian zones on privately owned agricultural land.

This chapter begins with an explanation of the survey results. A description of the empirical model that includes specific variables that detail what each variable is designed to measure. Following this two different econometric regression models are estimated based on responses to the WTA question in the survey with results provided in section 5.4. A discussion of the empirical model results will be presented in next section. Finally, the chapter ends with a summary.

### **5.2 Survey Results**

A total of 4110 surveys were mailed out to the landowners in the study areas in July 2007. The overall effective response rate was 6.1 percent which is low but is consistent with similar studies (Shaikh et al. 2007; van Kooten et al. 2002;) using mail out survey to farms in prairie regions. The methods for the mail out did not enable the quantification of surveys not delivered or delivered to ineligible households. Therefore, the actual response rate may be higher if all survey destinations could be defined.

Between the two regions, CAR 8B which is located in the dark brown/ black soil area, had a higher response rate (6.5 percent) than CAR 3AN (5.2 percent), located in brown soil zone. It is suspected that this is primarily due to harvest operations in the southern area starting unusually early in 2007 compared to harvest initiation in the central portions of the province. As a result, landowners in CAR 3AN had less time and greater work conflicts to finish the survey.

Personal and demographic information from the survey were compared with equivalent parameters from Canada's 2006 Census of Agriculture to evaluate the consistency of the sample population with the provincial population (Table 5.1). Despite the low survey response rates, the differences between the survey population and the census age, off-farm income, and education data were not statistically significant. The average farm size reported by survey landowners was comparable to the Saskatchewan farm size, which has the largest average farm size in Canada. Average age of landowners in both study areas was approximately 50 years old and the average level of education was high school. The percentage of landowners with off-farm income in CAR 8B was slightly higher (7 percent) than that of CAR 3AN. For those farms with a single operator, only 11 percent indicated that the management of their farm would be taken over by someone in the family if they retired within next 10 years, 46 percent reported no and 42 percent were unsure. Nearly 20 percent of the landowners were uncertain about how long they will continue to farm. These uncertain farm management plans may influence landowners' decision to accept environmental conservation policies.

Table 5.1 Comparison of survey data with Census Canada (N represents sample size)

Characteristic	8B (N) <sup>a</sup>	3AN(N) <sup>a</sup>	All(N) <sup>a</sup>	SK	Canada
Average Age	52.97 (157)	53.98 (55)	53.24 (212)	52.6 <sup>b</sup>	52 <sup>b</sup>
Average Education	High School Diploma (157)	High School Diploma (55)	High School Diploma (212)	High School Diploma <sup>c</sup>	High School Diploma <sup>c</sup>
Landowners with Off-farm income (%)	58 (157)	51 (55)	56 (212)	48.3 <sup>b</sup>	48.4 <sup>b</sup>
Average Farm size (ha)	682 (151)	820 (55)	718 (206)	587 <sup>d</sup>	295 <sup>d</sup>
<sup>a</sup> Original data obtained from the survey of Saskatchewan landowners in 8B and 3AN					
<sup>b</sup> Statistics Canada (2006b)					
<sup>c</sup> Statistics Canada (2006c)					
<sup>d</sup> Statistics Canada (2006a)					

To quantify the necessary financial incentives to induce the adoption of a wetland conservation program a WTA question was included in the survey. A discrete single bid approach was applied to this question which requires a large sample size to develop the distribution of all the bid levels. The results from the survey showed that 42 percent of all respondents (89 out of 212) accepted the proposed program bid, 18 percent respondents (38 out of 212) directly refused the program offer and remaining 40 percent respondents (85 out of 212) did not complete the WTA question (Table 5.2). The proportion of acceptance responses at each bid level, even though it did not strictly increase as the bid value rose (particularly in CAR 3AN), suggested an overall higher acceptance rate at a higher bid level and showed a 50 percent or so acceptance rate, if compensation value was greater than or equal to \$30/acre ( \$74.1/ha). The jumps in the response rate numbers (particularly in CAR 3AN) were mainly due to the relatively small sample size this survey received. Landowners in CAR 3AN showed more interest in the financial compensation payment (52.7 percent) than landowners in CAR 8B (38.2 percent) (Table 5.3). Except the \$25 and \$45 level, at all other bid levels the acceptance rate of WTA question in 3AN was higher than that in 8B. This result encouraged examination of the impact of landscape characteristics on adoption



of conservation programs. A detailed analysis will be presented in the following sections.

In order to determine the reasons why certain landowners did not accept the program offer, their attitude towards the program and wetlands was analyzed based on their comments and answers to other survey questions. For those respondents who directly said no to the bid offer, the reason was largely because of their perception that insufficient financial compensation was provided (indicated by the comments). For the remaining 40 percent of the respondents who did not complete the WTA question, the source of this uncertainty mainly came from concerns with wetland management (e.g. too many ducks and geese, land clearing investments, etc.) and changes in personal status (e.g. retirement, farm sale, etc.), even though the majority were in favor of environmental conservation (according to landowners' comments). In addition, the greater available water that landowners' in CAR 8B had experienced in the year when the survey was conducted was likely an important reason they were hesitant to implement a wetland conservation program.

Table 5.2 WTA response rate by bid category

Bid category	Yes response	No response	N/A response	All respondents	Acceptance rate
\$10	8	10	14	32	25.0%
\$15	8	5	4	17	47.0%
\$20	6	6	9	21	28.6%
\$25	10	7	13	30	33.3%
\$30	11	3	7	21	52.4%
\$35	8	0	9	17	47.0%
\$40	9	2	6	17	52.9%
\$45	10	1	9	20	50.0%
\$50	10	2	6	18	55.6%
\$55	9	2	8	19	47.4%
Total	89	38	85	212	42.0%

Table 5.3 WTA acceptance rate of two study areas at each bid level

Bid category	8B	3AN
\$10	18.0%	40.0%
\$15	46.2%	50.0%
\$20	13.3%	66.7%
\$25	36.4%	25.0%
\$30	50.0%	100.0%
\$35	38.5%	75.0%
\$40	37.5%	66.7%
\$45	53.3%	40.0%
\$50	50.0%	100.0%
\$55	46.2%	50.0%
Total	38.2%	52.7%

## 5.3 Econometric Model Specification

### 5.3.1 *The Basic model*

The model specification portion of this study provides a detailed examination of the various characteristics and factors that influence landowner adoption of the wetland conservation program. Using a stated preference approach, landowners' WTA has been elicited to estimate the level of financial incentive needed to encourage conservation adoption.

In the model, the dependent variable is the landowners' WTA the program payment to restore and maintain wetland and riparian area on their private land. Since about 40 percent of respondents did not answer the WTA wetland conservation question, analysis of these non-respondents was developed to provide additional information. Rather than ignoring these non-respondent answers, this study estimates

two different econometric models (Lynch et al. 2002; Train, 2003). The first model is a binary probit model which considers the non-respondent answers as missing values and only includes those “yes” and “no” answers for analysis. To code these responses the models equate “yes” with 1 and “no” with 0. The second model specification is a multinomial probit model that takes the non-respondent answers into account and assumes that landowners answered the question on the basis of the level of utility each choice brings. The dependent variable has been divided into three categories, with “no”=0, N/A response=1 and “yes”=2. If the landowner chose “yes” in the survey, then it is assumed that accepting the offer and conserving wetlands brings the landowner greater utility ( $u$ ) than the other choices. If the landowners did not answer the question, it means that neither accepting nor refusing the offer will produce any more utility for them, then a N/A answer would be given. There are many reasons respondents may not have answered the WTA question such as they are indifferent between accepting the program or not, they lack sufficient knowledge background to complete the question or, they are uncertain about future management plans as discussed in section 5.1. The decision is represented as

$$\begin{aligned}
 Y_i &= 2 \text{ (willing to accept)} && \text{if } u_2 > u_0, u_1 \\
 Y_i &= 1 \text{ (N/A response)} && \text{if } u_1 > u_0, u_2 \\
 Y_i &= 0 \text{ (unwilling to accept)} && \text{if } u_0 > u_1, u_2
 \end{aligned}$$

where  $u_i$  are true utility level for corresponding stated preference  $Y_i$ .

In this analysis, the estimation of two different models enables the regression results to be compared to provide further information for analysis concerning the impact of various characteristics on the landowners’ decision. Specifically, it enables an analysis of the impact of attitudinal characteristics on those respondents who do not complete the WTA question<sup>8</sup>.

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<sup>8</sup> An ordered probit model which assumes that a natural ordering exists in the discrete choices is also estimated during the research process. This model does not perform as well as the multinomial probit model. And according to the conclusion drawn by Lori et al. (2002), it is not appropriate to put “don’t know” answers as a middle group indicating a middle utility level.

### ***5.3.2 Explanatory Variables***

This section details the specific explanatory variables used in the econometric model. The explanatory variables chosen for this study are selected on the basis of previously published research discussed in the literature review (Chapter 2) concerning adoption of environmental conservation management plans. Some additional variables are also included in the model because they have been found to influence or are hypothesized to affect the wetland and riparian area conservation plan adoption. Specific information is provided below.

#### ***5.3.2.1 Data Selection***

The survey data has been applied in the study to conduct an econometric analysis of the influence of demographic and attitudinal characteristics on wetland conservation management decisions. Given the large number of parameters included in the survey, there are many possible ways to specify the model. As such, it is important to select those variables that are most appropriate for the research question. The selection of explanatory (independent) variables in the current regression model has been initially implemented in SPSS v.16 using a backward elimination approach for non-linear models to help determine the most relevant independent variables. This approach has been intensively used in related research (Wu et al. 2000; Wu et al. 2002; Shaikh et al. 2007). In backward elimination, the model begins with all variables included and then removes variables from the model one at a time (Zellner et al. 2004). This is done by calculating the Likelihood-ratio (LR) statistics and significance for all variables included and then by comparing the significance of the most insignificant variable in the full model with the probability criterion for a variable removal process. If the significance of the variable is larger, the model is modified by dropping this most insignificant variable and keeps repeating the steps to estimate the modified model. The procedure continues until only one variable is left in the model or until all variables in the model meet the criterion to stay. In this study, 0.1 was used as the

significance level to maintain a variable in the backward elimination procedure. It should be noted that forward selection is an alternative variable selection process that adds variables to the model one by one instead of dropping. The drawback of this method is that it cannot take into account the situation when two variables together can explain the variation of the model if either variable individually is not useful enough since forward selection only adds one variable at a time. Backward selection does not have such a problem since it already contains both variables and will not drop either one of them (Rogue Wave Software, 1999; Zellner et al. 2004).

Based on the selection results provided by the backward elimination approach, fourteen variables were retained in the final model. However, some parameters of interest were removed during the elimination process and some of those excluded variables were expected to have a practical impact on landowners' participation decisions according to past experience. In order to examine the potential influence of such explanatory variables on the dependent WTA variable, six additional variables were chosen on the basis of the results from previous published research were also included in the final model for regression analysis and further discussion.

#### **5.3.2.2 Description of Variables**

The relationship between landowners' willingness to participate in the wetland conservation management program and the economic incentive payment offered is hypothesized to be conditioned on four categories of explanatory variables, a) farm variables, b) landowners' preference, c) past experience and d) demographic and sociological variables (Table 5.4). A description of each variable included in the econometric model, detailed explanation of the variable and the expected relationship is provided in the following discussion.

Table 5.4 Variables expected to influence the participation decision

Categories & Variables	Variable Description
<b><i>Dependent</i></b>	
WTIWB	Willing to conserve wetland and riparian zones in private land—Binary (1= yes, 0= no)
WTIWM	Willing to conserve wetland and riparian zones in private land—Multinomial (2= yes, 1 =N/A, 0 = no)
<b><i>Independent</i></b>	
PAYMENT	Annual Payment per acre for participation in the program
<b><i>Farm</i></b>	
SOIL*	Soil type of the farm (1= brown soil zone, 2= dark brown/black)
GRAIN*	Proportion of land holdings allocated to grain production (%)
ACRES	Farm acres owned (farm size)
<b><i>Wetland Preference</i></b>	
PESTS	Wetlands harbor undesirable pests (-1=disagree, 0=neutral, 1=agree)
AESTHETIC	Wetlands are pleasing to see (-1= disagree, 0=neutral, 1=agree)
EROSION	Wetlands help erosion control (-1=disagree, 0=neutral, 1=agree)
COSTLY*	Wetlands are costly to maintain (-1=disagree, 0=neutral, 1=agree)
WILDLIFE	Wetlands are important for wildlife (-1=disagree, 0=neutral, 1=agree)
EQUIP	Wetlands make field operations more difficult and/or expensive (-1=disagree, 0=neutral, 1=agree)
BENEFIT	Benefits of wetlands > disadvantages (-1=disagree, 0=neutral, 1=agree)
<b><i>Past Experience</i></b>	
DRAINED	Drained wetlands within last 10 years (1=yes, 0=no)
PERM	Currently maintain riparian areas around permanent wetlands (1=yes, 0=no)
SEASON	Currently maintain riparian areas around seasonal wetlands (1=yes, 0=no)
MNGTPL	Have completed a management plan for farm (1=yes, 0=no)
<b><i>Demographic &amp; Sociological</i></b>	
AGE*	Age of the primary farm operator (years)
EDUC*	Completed education (1=primary/secondary, 2=high school, 3= college, 4=bachelor's, 5= graduate)
OFFINC*	Off-farm income (1=yes, 0=no)
MNGTM	Length of time the operator managing farm (years)
HEIR	Respondent expects a heir to continue farming (1=yes, 0=otherwise)

\* Variables added to the model after backward selection process

Source: Original data obtained from a survey of Saskatchewan landowners

The dependent variable used in the econometric model was the landowners' decision to accept the wetland and riparian area conservation program payment. Since two different regression models were developed, two groups of dependent variables are defined. WTIWB is the dependent variable adopted in the binary probit model for which non-respondents were considered missing values. WTIWM is the dependent variable for multinomial probit model which took non-respondents into consideration and divided the WTA answers into three separate groups (Table 5.4).

PAYMENT represents the level of per acre annual financial incentives the program provides for landowners. The PAYMENT parameter corresponds to the monetary compensation  $P$  in the discrete choice random utility model. Ten different levels of incentive values were randomly assigned to farmers in each of the two census agricultural regions. It was expected that with higher incentive payments, the probability the landowner would be willing to adopt the conservation plan will also increase. This is because landowners will try to maximize their utility according to utility maximization theory as discussed in section 4.3.2.3. Higher incentive payment is important in helping reduce landowners' unexpected production risk, compensate for their opportunity costs of the wetland and riparian area and thus improve the utility. Therefore, landowners receiving a higher compensation amount are considered to be more likely to accept the offer.

The three *Farm* variables included in the model are intended to measure the influence of regional factors and land use patterns on landowners' decision. Soil zone variable (SOIL) was created to account for any regional differences of the two study sites that are not captured by other explanatory variables. As mentioned in Chapter 4, there are biophysical differences between the two sites. This variable will capture the effect of soil fertility, vegetation, precipitation and temperature differences.

The type of the farm operation (GRAIN) is included in the model since it was expected that farming operation type plays an important role in determining landowner's decision. It was expected that farms with a higher proportion of crops

would require more compensation compared to farms with more livestock. When the economic viability of the farm relies heavily on grain, they will be more cautious in examining the program and determine the payment amount because the decision will have a large impact of their cropping production output and revenue.

Total farm area (ACRES) represents the area of farm managed. Farm size was incorporated in the analysis because of its association with fixed adoption costs, labor availability and management model (Feder, et al. 1985). The size of the farm determines the farm's ability to achieve economies of scale in production, to earn greater gross income, to raise external financial capital and to bear the impact of volatile market price on their agricultural products. In addition, with the adoption of a conservation program, the land distribution will change, so does the type of field operation. Wetlands as field obstructions may have a different impact on smaller farms that use smaller equipment compared to and larger farms and therefore the net return received by landowners.

Landowners' preference in regard to wetland and riparian area issues was taken into account in this study to capture the influence of landowners' opinion and perception towards the value of wetlands on the adoption decision. All respondents were asked to express their level of agreement with various statements concerning wetlands on their private land. PESTS, COSTLY and EQUIP are three variables that represent landowners' attitudes towards the potential disadvantages of wetlands. If the landowners find that the existence of wetland would bring undesirable types and amount of pests that harm crops or cattle to their farm areas, it is expected that they would be less likely to accept the conservation program. Similarly, when the landowners consider the wetland too costly and difficult to be maintained, they will hesitate to say yes to the offer or will require greater levels of compensation payment. In contrast, AESTHETIC, EROSION and WILDLIFE enable landowners' to express their opinion on the beneficial aspects of wetlands. If the landowners consider wetland cover in the region to enhance the visual appeal of the landscape, believe that wetlands



control soil erosion and play an important role for wildlife, it is assumed that the probability that they will agree to adopt the program increases. BENEFIT is intended to capture landowners' view of values of wetlands and riparian areas. It is expected that BENEFIT contributes positively to the adoption of conservation practices.

Previous participation in environmental conservation was also expected to influence the landowners' decision making process. Landowners involved in environment-friendly practices or behavior in the past were considered to be more likely to adopt similar measures due to their preference for the environment or the additional knowledge benefit gained from such programs. PERM and SEASON will be positive if landowners already practice some form of riparian and/or wetland conservation on the landscape. The presence of these preferences was thought to have a positive effect on the probability of accepting the payment. Previous adoption of a defined farm management plan (MNGTPL) is included to examine if a landowner with a management plan will be more willing to accept the program offer as the plan will enable landowners to manage their farm based on a long-term planning horizon. In contrast, the DRAINED variable is included to help understand whether landowners with wetland draining experience would be more or less likely to adopt the conservation program.

The AGE variable is included to capture the differences between younger and older landowners including the working status and future income perception of the respondents. It is expected that the age of the farm manager will influence the decision to participate in the program. Land with wetland easements or contracts will sell for less due to the reduced flexibility for the buyer regarding land use. Since older landowners may be more concerned with maximizing the selling price of land, they may choose to refuse the program offer. On the other hand, older landowners may be more prone to adopt the program because of reduced workloads and stable annual income (Shaikh et al. 2007).

Level of education attainment (EDUC) is included to examine if there is a correlation between formal education level and landowners' conservation adoption decisions. According to previously published research, education does not have a strong impact on landowners' adoption decisions (Kingsbury and Boggess, 1999, Upadhyay et al. 2002; Gedikoglu and McCann, 2007).

Landowners' off-farm income is represented by the OFFINC variable. It is included in the model to investigate if landowners with an off-farm income would rely less on the revenue from farming production and devote less time to farm management. The length of time that landowners act as decision makers on the farm (MNGTM) is included in the model to examine how management horizons are correlated with landowners' farming experience and farming management capability. The variable HEIR reflects whether the landowner will change the conservation adoption decision if he/she has children or relatives to take over the farm management when he/she retires. This would be helpful to understand if the landowners' decision is affected by the length of farmland ownership and their perspective for future plans.

### ***5.3.3 Regression Descriptive Statistics***

The descriptive statistics are for the entire data and include all three groups of respondents. This analysis was completed in SPSS v.16. t-statistics were ran on the continuous variables to compare the differences between willing and unwilling landowners while chi square statistics were ran for discrete choices variables, both using a 5 percent level of significance (Table 5.5). If the difference between the variable means is significant at the 95 percent level, the variable is anticipated to be significant in the following probit model, as the different values of this variable is more likely to result in different responses.

Table 5.5 Descriptive statistics

Variables	Unit	All respondents (N=212)		Yes responses (N=89)		No responses (N=38)		N/A Responses (N=85)	
		Mean	Std. D.	Mean	Std. D.	Mean	Std. D.	Mean	Std. D.
PAYMENT*	\$	30.48	14.59	32.58	14.37	25.58	14.65	28.67	14.00
<i>Farm</i>									
SOIL	(1,2)	1.74	0.441	1.65	0.48	1.81	0.40	1.82	0.39
GRAIN	%	78.4%	33.5%	75.6%	35.2%	89.4%	21.5%	80.9%	31.7%
ACRES	acres	718	677	684	638	917	890	693	521
<i>Wetland Preference</i>									
PESTS	(-1,0,1)	-0.17	0.76	-0.29	0.82	-0.15	0.73	-0.13	0.76
AESTHETIC*	(-1,0,1)	0.37	0.73	0.45	0.73	0.31	0.74	0.29	0.76
EROSION	(-1,0,1)	0.66	0.60	0.82	0.43	0.58	0.70	0.67	0.56
COSTLY	(-1,0,1)	-0.16	0.73	-0.18	0.74	0.12	0.59	-0.29	0.70
WILDLIFE	(-1,0,1)	0.80	0.46	0.85	0.44	0.88	0.33	0.78	0.47
EQUIP*	(-1,0,1)	0.25	0.76	0.20	0.75	0.54	0.71	0.18	0.81
BENEFIT*	(-1,0,1)	0.37	0.68	0.53	0.53	0.00	0.80	0.33	0.67
<i>Past Experience</i>									
DRAINED	(0,1)	0.33	0.47	0.39	0.49	0.42	0.50	0.22	0.42
PERM*	(0,1)	0.56	0.50	0.68	0.47	0.27	0.45	0.49	0.50
SEASON*	(0,1)	0.40	0.49	0.48	0.50	0.08	0.27	0.38	0.49
MNGTPL	(0,1)	0.60	0.49	0.62	0.49	0.65	0.49	0.53	0.51
<i>Demographic &amp; Sociological</i>									
AGE	years	53.24	13.04	54.98	10.77	53.08	13.46	53.67	12.38
EDUC	(1-5)	2.49	1.03	2.64	1.06	2.77	1.14	2.29	0.87
OFFINC	(0,1)	0.52	0.50	0.53	0.50	0.50	0.51	0.49	0.51
MNGTM	years	27.8	14.5	28.79	13.23	27.04	13.52	27.53	15.39
HEIR	(0,1)	0.93	0.87	1.05	0.87	0.96	0.87	0.84	0.93

\* Significant at  $P < 0.05$ 

Source: Original data obtained from a survey of Saskatchewan landowners

Based on the results, the average compensation required to enable respondents to conserve wetlands is \$30.48. The average payment for landowners who said “yes” is higher (\$32.58) than those who said “no” (\$25.58). For CAR 8B, the mean WTA value is \$31.25 and for CAR 3AN the mean WTA value is \$28.82, which is consistent with expectation and the differences in means are statistically significant. In order to evaluate the representative of the WTA value obtained, land rental values within those landscapes were assumed to represent the opportunity cost of retiring wetland. By comparing with the land rental values, it is encouraging that these WTA values are within the distribution of actual land rent in those two study areas (Table 5.6) and serves as an indicator of landowners’ perceived cost of wetland conservation.

Table 5.6 Opportunity cost of retiring wetland

CAR	Rental Rates <sup>a</sup>		
	Minimum (\$/acre)	Maximum (\$/acre)	Mean (\$/acre)
8B	10.00	47.98	30.84
3AN	19.99	34.98	25.00
<sup>a</sup> SAF (2006)			

The mean for variable PERM and SEASON are found to be significantly different between willing and unwilling landowners indicating that landowners willing to conserve wetlands and riparian areas have more of their current land allocated to such lands compared to those unwilling to conserve. Statistical differences also exist in the wetland preference variables even though the differences in the mean for these variables are small between the two groups of landowners. For example, landowners willing to conserve wetlands tend to be more likely to agree with the statements that the benefits of wetlands exceed their disadvantages. However, the results revealed no significant differences between landowners with different demographic and sociological characteristics. The next section will present the results of the estimated

model and further explore the relationship between landowners' and farm's characteristics (explanatory variables) and willing to accept program decision (dependent variable).

## **5.4 Results and Discussion**

### ***5.4.1 Introduction to the Model***

The analysis was based on probit regression models using the statistics software STATA v.9.2. For the purpose of this study, the null hypothesis is that the particular coefficient estimator is equal to zero given the rest of the variables in the model, while the alternative hypothesis is that the coefficient is not zero. The procedure of selecting explanatory variables for the regression models was discussed in section 5.3.2. Both binary and multinomial regression models were estimated. To evaluate the effectiveness of the models, z-statistics were used to determine the significance of individual coefficient estimators in the models. The z-statistic represents the ratio of the coefficient to the standard error of explanatory variables and follows a standard normal distribution to test alternative hypotheses about the coefficient (UCLA Academic Technology Services, 2008).

The estimated coefficients in the non-linear regression models such as probit or logit model require some specific explanation to effectively interpret the results. In linear models, coefficients can be interpreted as marginal effects. However in non-linear regression models, this interpretation is complicated by the fact that the usual coefficient estimates are not the marginal effects that we are accustomed to and do not have a direct economic interpretation (Greene, 2003; Anderson and Newell, 2003; Shaikh et al, 2007). As a result, the coefficients must be manipulated in order to explore the changes in the predicted probability of adoption associated with a one unit change in the explanatory variables while holding the rest of the variables constant. Marginal effects for a continuous variable is represented by its slope, assessed at the

sample mean. For a dummy variable, the marginal effect is calculated based on the sample means of all the other variables in the model<sup>9</sup>. Due to these characteristics, an additional “marginal effect” value was calculated in this study and is provided in the results section. Estimated coefficients are also presented in order to indicate the direction of the effect of a change in the explanatory variable. Marginal effects discussion in the exploration for participation decisions can also be found in similar research applications (Lynch et al. 2002; Shaikh et al. 2007; Kline et al. 2000).

### **5.4.2 Model Results**

Both binary probit and multinomial probit were ran using the survey data set. However, not all returned questionnaires were applied in the probit estimation due to the problem of missing values. Only those surveys for which none of the response and predictor variables were missing have been used as observations for the regression models. Therefore, 92 observations were used to estimate the binary probit model and 137 were used to estimate the multinomial probit model for WTA respectively (Table 5.6 and 5.7). In the multinomial model, the value of the “no” response was selected as the base category for the estimation, which is used to specify the outcome to normalize the location of the latent variable. The coefficients for the base category were set to zero and the coefficients of the other two response groups were used to estimate the utility difference from the base outcome.

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<sup>9</sup> Marginal Effects for a continuous variable is equal to  $\partial E[y | x] / \partial x = f(\beta'x)\beta$  where  $f$  is the corresponding probability density function. For the Probit model,  $f$  is given by  $\phi$ , the standard normal density function. Marginal Effects for a dummy variable is  $\partial E[y | dum] / \partial dum = \Pr[y = 1 | \bar{x}, dum = 1] - \Pr[y = 1 | \bar{x}, dum = 0]$ , where  $dum$  represents the estimated parameters for the dummy variable and  $\bar{x}$  denotes all the other variables evaluated at their sample means. Details see Greene (2003, P.667).

Table 5.7 Coefficient estimates for binary probit model

Variables	Coefficient	Marginal Effects	Std. Error
Constant	-3.450	--	2.756
PAYMENT	0.045**	0.006	0.021
<i><u>Farm</u></i>			
SOIL	-0.410	-0.055	0.653
GRAIN	-0.212	-0.028	0.958
ACRES	-0.001*	-0.0001	0.000
<i><u>Wetland Preference</u></i>			
PESTS	1.120**	0.149	0.472
AESTHETIC	-1.295**	-0.173	0.545
EROSION	1.747*	0.233	0.905
COSTLY	-0.548	-0.073	0.478
WILDLIFE	-1.965	-0.262	1.194
EQUIP	-0.975*	-0.130	0.511
BENEFIT	1.220*	0.163	0.627
<i><u>Past Experience</u></i>			
DRAINED	1.257**	0.152	0.626
PERM	1.944**	0.341	0.707
SEASON	2.969**	0.351	1.053
MNGTPL	1.135*	0.194	0.592
<i><u>Demographic &amp; Sociological</u></i>			
AGE	0.049	0.007	0.045
EDUC	-0.162	-0.022	0.277
OFFINC	0.273	0.037	0.543
MNGTM	-0.077*	-0.010	0.045
HEIR	0.990**	0.132	0.375
No. of observations = 92			
Log likelihood = -24.537			
Likelihood ratio $\chi^2$ (df) = 60.48 (20)			
McFadden $R^2$ = 0.5521			

<sup>a</sup> Huber/ White robust standard errors.

\* Indicates significance at 10% level or better. \*\* Indicates significance at 5% level or better.

Table 5.8 Coefficient estimates for multinomial probit model <sup>a</sup>

Variables	Coeff.	Response				
		Yes			N/A	
		Mar. Eff.	Std. Err. <sup>b</sup>	Coeff.	Mar. Eff.	Std. Err. <sup>b</sup>
PAYMENT	0.031 <sup>*</sup>	0.008	0.018	-0.025 <sup>*</sup>	-0.006	0.014
<i><u>Farm</u></i>						
SOIL	-0.465	-0.225	0.630	0.835 <sup>*</sup>	0.215	0.482
GRAIN	-0.863	-0.124	0.941	0.308	0.047	0.627
ACRES	-0.001 <sup>*</sup>	-0.0002	0.000	0.001	0.000	0.000
<i><u>Wetland Preference</u></i>						
PESTS	0.845 <sup>**</sup>	0.026	0.418	0.103	0.069	0.279
AESTHETIC	-1.086 <sup>**</sup>	-0.121	0.482	0.240	0.017	0.354
EROSION	0.535	0.170	0.596	-0.583	-0.141	0.450
COSTLY	-0.028	-0.133	0.437	-0.570 <sup>*</sup>	-0.163	0.340
WILDLIFE	-1.594 <sup>**</sup>	-0.124	0.768	0.122	0.040	0.459
EQUIP	-0.747 <sup>*</sup>	-0.091	0.428	0.198	0.021	0.294
BENEFIT	1.931 <sup>**</sup>	0.310	0.629	-0.825 <sup>*</sup>	-0.144	0.482
<i><u>Past Experience</u></i>						
DRAINED	1.492 <sup>**</sup>	0.418	0.642	-1.550 <sup>**</sup>	-0.342	0.509
PERM	1.555 <sup>**</sup>	0.250	0.632	-0.664	-0.105	0.549
SEASON	2.558 <sup>**</sup>	0.185	0.873	-0.238	-0.036	0.524
MNGTPL	0.895	0.211	0.545	-0.667	-0.144	0.415
<i><u>Demographic &amp; Sociological</u></i>						
AGE	0.053	0.019	0.040	-0.066 <sup>**</sup>	-0.016	0.032
EDUC	-0.383	-0.045	0.283	-0.285	-0.099	0.205
OFFINC	0.366	0.064	0.507	-0.176	-0.033	0.399
MNGTM	-0.059 <sup>*</sup>	-0.012	0.035	0.036	0.008	0.026
HEIR	0.602 <sup>*</sup>	0.110	0.329	-0.313	-0.061	0.220

No. of observations = 137

Log likelihood = -141.5099

Wald  $\chi^2$  (df) = 47.68 (40)McFadden R<sup>2</sup> = 0.3012<sup>a</sup> WTA=0 is the base outcome<sup>b</sup> Huber/ White robust standard errors.<sup>\*</sup> Indicates significance at 10% level or better. <sup>\*\*</sup> Indicates significance at 5% level or better.



One way to examine the performance of the estimated model is using the correctly predicted probability, a hundred percent-based numerical value. If the predicted response calculated by the model is agreed with the real response provided by the landowner, this response is considered to be correctly predicted. For the current research, both models correctly predict over 60 percent of the “yes” and “no” responses, with binary probit model doing a little better correctly predicting 80.8 percent of the “no” responses and 94 percent of the “yes” responses. The multinomial probit model correctly predicts 60 percent of the “no” responses, 84.6 percent of the “yes” responses and 55.6 percent of the N/A responses. This finding shows a reasonable prediction ability of the model and is comparable to similar research that has applied the probit model (Lynch et al. 2002; Davey, 2006). Collinearity among the variables was also checked using STATA v.9.2 (See Appendix B). No serious systematic problem with collinearity among variables was found<sup>10</sup>.

As hypothesized, in both models a statistically significant, positive relationship is found between the magnitude of the offered payment and the probability that landowners are willing to adopt the wetland conservation program on their lands. A marginal increase in the payment (\$1/year) corresponds to an increase in the probability of acceptance of the payment ranging from 0.6 percent for the binary probit model to 0.8 percent for the multinomial probit model, as revealed by the marginal value.

Within the *Farm* variables, ACRES which represent each farm’s total area is the only variable statistically significant. A negative relationship in the model indicates that landowners who manage less land would be more willing to adopt the conservation activities. This may be the result of highly variable agricultural commodity prices which brings higher pressure and risks to small farms. Accepting a fixed annual payment may be one way for these landowners to secure some income. Further, as land use varies landowners must change their field operations. For smaller farms, equipment is smaller resulting in the cost of field obstruction often being lower

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<sup>10</sup> Correlations are less than 0.5 in most cases therefore there is no serious collinearity problem among variables.

than on large farms. This conclusion is supported by the EQUIP coefficient indicating that if landowners believe that wetlands are hard to maneuver around with farm equipment they are less likely to accept the WTA bid. However, even though the relationship is significant, the real marginal effect of this independent variable on the probability of a “yes” response to the bid is relatively minor, ranging from 1 percent to 2 percent per 100 acres (per 40.5 ha) change in farm size.

SOIL and GRAIN are two explanatory variables that were added to the model after the backward selection process. They were included due to a significant impact of land location and production type on landowners’ participation in land conservation programs being reported in previous published literature (Shaikh et al. 2007; Hua, et al 2004; Ferguson, 2005; Lambert et al. 2003). Although the estimated coefficients of these variables were not significant at the 10 percent level in the current study models, the impacts might still exist but the probability is not high enough to have confidence in (Ferguson, 2005). For the SOIL variable, a negative sign is found in both models implying that landowners in dark brown/black soil zone (CAR 8B) are more hesitant to conserve wetlands and may require greater compensation payment. CAR 8B is characterized with greater levels of precipitation and lower evaporation resulting in wetter soil than CAR 3AN. Although landowners in CAR 8B may consider the conservation program itself as an acceptable offer, they may be hesitant when asked to bring more wet areas into the landscape as they already receive sufficient precipitation during the growing season. In addition, many landowners have spent considerable time and money clearing wetlands and riparian trees, they are likely to demand higher incentive payment to compensate for their effort to reinstall these areas (van Kooten et al. 2002). In contrast, landowners in CAR 3AN have a drier landscape and providing wetlands in the landscape may help them mitigate water access issues to some extent. For the GRAIN variable, the negative relationship indicates that landowners who agree to conserve wetlands and riparian areas are less likely to depend on cropping as their primary operation type. In other words, those landowners who agree to conserve wetlands have more of their land allocated to perennial cover such as hay and pasture

and therefore likely gain some of their income from livestock resulting in a lower opportunity cost imposed by wetlands on the land.

Many previous studies have examined the relationship between landowners' environmental perceptions and conservation practice adoption decisions. However in this research, the correlation is somewhat ambiguous with both positive and negative relationships found for a particular opinion (Hua, et al 2004; Cuddington, 2008; Kingsbury and Boggess, 1999). In the current study, both models found that landowners who agree with the concept that wetlands and riparian zones are important for erosion control (EROSION) are more likely to accept the program and conserve wetlands. Similar results were found for the BENEFIT variable. Specifically for those who believe that the benefits of wetlands outweigh their disadvantages, their probability to accept the offer is 16 percent higher at the margin in the binary probit model and 31 percent higher in multinomial model. COSTLY is one of the six added variables. Although it is not statistically significant in either model, its negative relationship implies that landowners would not be willing to conserve wetlands if they deem wetlands and riparian areas are costly to maintain in the landscape. Surprisingly, the coefficients for the opinion variables PESTS, AESTHETIC and WILDLIFE in both models are not consistent with expectations. The negative coefficient for the PESTS variable indicates that although landowners felt that wetlands might harbor undesired pests, they were still willing to accept the conservation payment. The negative coefficient of visual variable AESTHETIC implies that the landowner still may adopt conservation activity though he considers wetlands as visually unappealing. A similar conclusion was found for the WILDLIFE parameter, respondents that believe wetlands are important for wildlife but they still would not choose to accept the program.

A strong correlation is found in both models between past experience and landowners' decision to participate in the program. Landowners that already maintain wetlands and riparian areas on their landscapes are more willing to adopt the

conservation management than those who do not have such experience, which signifies a consistent environmental preference. This could be reflected by the two variables PERM and SEASON which are positive and statistically significant at the 5 percent level. This result indicates that landowners who already have greater areas of their land allocated to wetlands are more likely to comply with the wetland conservation program. Management plan variable (MNGTPL) turned out to be statistically insignificant in the multinomial probit model but significant at the 10 percent level in the binary probit model. This is probably due to the fact that a certain number of landowners, who did not complete the WTA question, do not have a defined management plan. The positive sign in both models suggests that landowners who have previously adopted a farm management plan were more likely to accept the program payment. The past draining experience variable (DRAINED) behaves contrary to expectations. Both models indicate that landowners who used to drain wetlands or riparian zones within last ten years are more likely to be willing to conserve wetlands. One possible explanation for this is the impact of the high conversion costs and the small stock of wetlands the landowner has on his land. If a landowner already drained many wetlands in the past, it would be quite costly for him to convert the remaining wetlands to cropland compared to leaving them as they are. Therefore these landowners would be more likely to accept the conservation management plan since they will maintain them as wetlands anyway. Further discussion will be presented in following sections.

The decision to participate in the wetland conservation program is also considered to be somewhat affected by demographic and sociological factors. However, for the AGE variable, other empirical studies have reported both positive (Shaikh et al. 2007; Kline et al. 2000; Amigues et al. 2002) and negative (Kingsbury and Boggess, 1999; Gedikoglu and McCann, 2007; Lynch et al. 2002) relationships between age and participation. The result in the present study suggests that older landowners are more

likely to adopt the conservation program, but the relationship is not significant. The previously published research has also shown that the relationship between education level (EDUC) and participation is uncertain (Kingsbury and Boggess, 1999, Upadhyay et al. 2002; Gedikoglu and McCann, 2007). In this study both models show an insignificant negative relationship between education and participation.

Off-farm income (OFFINC) is positively correlated with the decision to adopt wetland and riparian conservation indicating that landowners with more off-farm income would be more likely to adopt conservation management. The reason for this relationship is uncertain although those farmers with off-farm income may have different objectives for their land and different time constraints than farmers who depend on their land for all of their income. The conservation management with payment may fit better with the management practices of this group of farmers. The insignificant sign in this case might be due to the insufficient off-farm employment opportunities in the study areas.

The proxy management time variable (MNGTM) is used to measure the impact of farming experience on the conservation adoption decision. Based on previous findings, the direct relationship with participation in conservation program is ambiguous. On the one hand, landowners with more farming experience compared to newer farmers allows them to know more wetland benefits for the land and accept the offer. On the other hand, it is also possible they are more reluctant to make a major change to the current land allocation and prefer to keep the status quo land allocation. This research found a negative and significant coefficient at the 10 percent significance level suggesting that landowners with more years farming experience prefer to maintain current land use and rely on their income from farming production. However, the effect of an additional year in managing the farm corresponds to only a small decrease in the likelihood (around 1 percent) that the respondent accept the offer.

Everything else equal, landowners who intend to leave the farm to a relative or child (HEIR) are more likely to adopt the conservation management. The significant sign in both models suggests that continuation of the family farm influences

landowners' decisions. This is probably because landowners are making decisions on what is best for the farmland for a long-term period of time rather than the short-run benefits. Some benefits provided by wetlands could only be realized in the long-term such as flood control and erosion mitigation and thus are more suitable for farms with long planning horizons. It is assumed that keeping the land in a much healthier condition at the current stage would help improve productivity for future production and increase the potential land sales value.

As expected, the results from the binary probit model and the results from the “yes” responses of the multinomial model were quite similar. The binary probit model estimated thirteen significant variables while the multinomial model estimated twelve, with ten of the significant variables consistent across both models. Besides these estimation results, it is also worthwhile to highlight the factors that may have influenced the response of those landowners who did not complete the WTA question. These results provide insight into the reasons why landowners would not respond to the WTA question. According to the estimation results from the multinomial model, six variables had a significant impact, they are PAYMENT, SOIL, COSTLY, BENEFIT, DRAINED and AGE. These results indicate that landowners who are younger, living in CAR 8B area, who haven't drained in the last ten years, who believe that the disadvantages of wetland outweigh their benefits but are not costly to be maintained are more likely not to respond to the WTA question. Payment amount is also found to have negative impact indicating that the lower bid value landowners receive, the more likely they did not respond. Based on the above findings, it is of interest to note that payment amount is absolutely the factor landowners will consider when making the participation decision, but as indicated by the marginal effects of payment (0.6 percent) and cost variable (16.3 percent), it seems that this is not the most significant factor affecting their completion of the WTA question. Based on the responses, it is more likely that limited information of the program and benefits of maintaining wetland in the landscape may influence these non-responses. As indicated by the opposite sign of

variable DRAINED in yes and N/A responses model, landowners with previous drainage experience are more willing to conserve wetlands. For landowners who don't have previous drainage experience, the probability they do not respond to the WTA question is 34.2 percent higher than those with. This may be due to the knowledge they obtained from their drainage experience such as the impact on soil conditions and wetlands functions and benefits from wetland retention, which provide more motivation for them to protect in the future. In contrast, respondents without such experience do not have an opportunity to learn such information and are, therefore, less likely to respond. Further, the age variable indicates that older landowners with more wetland management and farming experience would be more likely to answer the question directly; however, this marginal effect is not very strong (1.6 percent). Attitude about wetlands and riparian areas (benefit<disadvantage) is significant at a 10 percent level indicating that some landowners do not reply because they personally dislike wetlands or they are not well informed about their benefits. The SOIL dummy variable is also a factor influencing the responses especially for those who live in a much wetter place in a much wetter year. This group of respondents might have specific responses if the survey was not conducted in a flood year but it is not possible to support this suggestion with existing data.

### ***5.4.3 Discussion***

#### ***5.4.3.1 Payment Variables***

Landowners' decision to participate in the wetland conservation program is affected by a combination of factors. However, the monetary incentive is one of the most important factors landowners consider in the decision process. Both models indicated that the probability of agreeing to conserve wetlands on their land increases with the level of incentive payment. The average payment required by respondents in CAR 8B is about \$31/acre (\$76.6/ha) and by respondents in CAR 3AN is around \$28.8/acre (\$71.2/ha) which is relatively similar to the land rental rates within the two

study areas respectively (\$30.9 in 8B and \$25 in 3AN).

Agricultural income has a history of being highly variable and it is possible that the financial incentives available from the wetland conservation program provide a less risky way for landowners to maintain income while enjoying the environmental benefits, which may enhance sustainable agricultural production in the future. For a government policy to reach a cost-effective goal of an economic incentive program, WTA would be a more appropriate way to determine payment amounts. According to Shaikh et al. (2007), this could effectively save between one-third and two-thirds of the policy implementation costs since landowners already receive other benefits such as reduced risk and environmental benefits or they might find an inherent value in wetlands (Cuddington, 2008).

For those respondents who did not complete the WTA question, the mean financial incentive amount was approximately \$28/acre (\$69.2/ha) which is the middle value among three mean compensation values. Combining this with the results from multinomial probit model, it is apparent that at this incentive level landowners are quite unsure about whether a yes or no answer should be presented. They might need more time to do the comparison, need extra help to get more information regarding the program, or need to take other factors into consideration in their final decision. Therefore, when completing the survey, they choose not to response to the question to indicate their uncertainty. This postulation is confirmed by some landowners' comments indicating that they do not respond because farming status will change in the near future even though they recognize the social benefits of wetland, and by information from other questions in the survey indicating that some landowners do not participate in an environmental program because of unfamiliarity with such a program.

#### **5.4.3.2 Farm Variables**

Farm variables do not seem to play a critical role in landowners' decisions as indicated by the insignificance of the coefficients and marginal effects in both models.



The only significant variable identified by the model was farm size (ACRES). However, the model indicates that the influence of this variable was relatively small.

The significant coefficient for the SOIL variable in the N/A response model may help explain one of the concerns landowners in CAR 8B might have about conserving wetlands in the agricultural landscape, beside the factor of financial incentive. In the brown soil zone (3AN) landowners who experience lack of moisture may be more willing to accept the presence of wetlands, perhaps as a reserve for soil moisture. However, in the dark brown or black soil zone (8B), landowners' willingness to accept is discouraged, for example, by having to deal with too much soil moisture at times or too many wetlands. Since landowners in 8B experienced a flooding year when the survey was conducted, their willingness to keep wetland, in the field might be diminished. Thus future farm survey research may be needed to determine if the same results hold true in other years with different climate conditions.

#### **5.4.3.3 Landowners Preference Variables**

Preferences for wetlands are regarded to be positively correlated with landowners' adoption behavior. However, according to Cary and Wilkinson (1997), environmental preference will not translate to consistent environment-friendly action unless there are economical or other benefits associated with the behavior. In our case, three opinion variables (PESTS, AESTHETIC and WILDLIFE) are significant within the model suggesting that respondents still would like to accept the program offer even though they consider that wetlands harbor unexpected pests, may not be pleasant to view and not considered to be important for wildlife. Alternatively, there are also several attitude variables that are consistent to the expectation and significant. The results of EROSION, EQIP and BENEFIT indicate that the program may be accepted because landowners believe that wetlands provide erosion control function, not difficult to manage and offer more benefits than disadvantages. This is an important finding as it implies that respondents' answers are influenced by those practical and

private benefits of wetland. The ease of management and wetland's actual function for the farmland is far more significant than visual and preference influence. This result suggests that landowners are unlikely to support programs that require increased field work or require greater management time. According to Gelso et al. (2008), increasing wetland dispersion contributes significant inconvenience cost to landowners. Based on these findings, a conservation policy such as targeting at farms with lower dispersed wetland or allowing landowners with flexibility to redistribute wetlands in the field without changing wetland acres may be more acceptable and will be adopted by landowners<sup>11</sup>. Although restoration costs incurred by the redistribution of wetlands can be quite high, this can be justified if operation costs are significantly less than the inconvenience costs (Gelso et al. 2008). The negative sign of WILDLIFE could be explained as either landowners' limited information of wetland functions or their personal aversion to the presence of ducks and geese, which can impose costs through crop depredation, on their private land.

#### **5.4.3.4 Past Experience Variables**

Past experience with wetland management, supported by both models, shows a significant influence on landowners' conservation adoption decision even it is wetland drainage experience. This is an interesting finding and one suggested implication is that landowner who had drainage experience in the past maintaining remaining wetlands in the landscape, would take the offer bid as it would be more acceptable and economical since the conversion costs are high. Another implication might be that previous knowledge about wetland and riparian area would be an important factor to encourage landowners to conserve them. As with previous experience, it would be obvious for landowners to compare the land status and find out the site difference before and after conserving or draining the wetland as discussed in section 5.4.2. These landowners may incur lower learning costs and related

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<sup>11</sup> However, a single permanent wetland may not provide the same range of environmental goods as more dispersed wetlands of different size and permanence. But this policy may work as a second best solution to keep the wetland in the landscape.

information costs of wetland advantages, buffer installation and government support programs etc. (Lynch et al. 2002). Therefore, it is easier for these farmers to recognize the overall benefits and disadvantages of maintaining wetland and riparian zones.

Combining the relationship between past experience and landowners' conservation adoption with the result of significant variables BENEFIT and DRAINED in the N/A response model may further support the above conclusion. The negative signs of these two variables indicate that those who did not answer the WTA question are those landowners who have limited experience with managing land that includes wetland, and less knowledge about the benefits of wetlands and riparian areas. Based on these findings, a well defined economic incentive program is anticipated to yield higher level of benefits if working in conjunction with an education program to reduce certain amount of transaction costs imposed during implementation.

#### **5.4.3.5 Demographic and Sociological Variables**

The results from the demographic and sociological variables suggest that landowners' farm management experience and the existence of an heir to take over their farm business are two significant influences landowners consider to adopt wetland conservation activities. The age of the landowners, however, does not seem to influence the landowners' decisions. This is probably because heir and age variables are representing similar characteristics and the impact of age is weakened by the presence of the heir variable, since the landowners' decision will be more likely affected by the existence of an heir rather than their age. For example, if a landowner is 70-years old and he has no heir to take over the farm when he retires, it is hard to predict whether he will accept the conservation plan or not since he might want to exploit the land as much as possible and refuse the offer, or, he might want to reduce the workload and accept the offer. But if the landowner has an heir, it is very likely that he would accept the offer since the landowner will consider the farmland from a long-term perspective. Thus, wetland policy may be more effective if targeted to

producers either with an heir to take over the farm when they retire or those having a management plan to achieve long-term benefits.

In contrast to the above discussion in the N/A response model, age was revealed to have a significant impact implying that young landowners are more likely not to complete the WTA question. The probable reason for this is that young landowners have longer farming planning horizons and there is no need for them to consider the heir problem. Therefore, the impact of heir variable is reduced. Young landowners are also characterized by less farming and management experience which further increases the uncertainty during their decision making process.

## **5.5 Summary**

This chapter examines the use of incentive-based policy to encourage landowners to conserve wetlands and riparian zones in their agricultural landscape. Farm and landowners' characteristics have been assessed to evaluate their influence on the magnitude of economic incentive needed. Both binary probit and multinomial probit model were run using the survey data collected from the two designated study sites. Results from the two models did not differ significantly in either significant variables or their ability to correctly predict variables. According to the results, landowners' decisions are mainly affected by the magnitude of the payment, landowners' attitude towards wetlands and riparian areas, and their previous wetland management experience. Farm characteristics and demographic factors of landowners only had a limited influence. For those landowners who did not answer the WTA question, the N/A response model shows that whether the landowner had previous wetland draining experience could play a significant and decisive role. The next chapter will conclude the thesis by briefly synthesizing the survey and model results and discussing the limitation and recommendation for further relevant study.

## **CHAPTER 6 SUMMARY AND CONCLUSION**

### **6.1 Introduction**

The purpose of this chapter is to provide an overview of the major findings from the analysis and results sections of this thesis. First a summary of the research findings from theoretical framework, the landowners' survey and the key results of the analysis are provided. This is followed by a discussion of policy implication from the empirical work. Finally, the primary study limitations are discussed, along with recommendation for future research.

### **6.2 Summary**

Wetlands provide a wide variety of habitat types and, together with associated riparian zones, produce important resource outputs to society. The literature explored in Chapter 2 highlighted the importance of wetland and riparian zones in an ecological system, their current status and existing threats to their structure and function. Given the public good characteristics of many of the goods and services provided by wetland and riparian areas, government participation is considered to be critical to achieve wetland conservation goals. Although many policy measures have been applied to protect wetlands, there is still a long way to go to develop a comprehensive wetland policy. Specifically in the province of Saskatchewan, it appears that few instruments are dedicated to ensure wetlands are conserved within privately-owned farmland.

Economic valuation plays a role in assisting wetland management and informing policy development through the process of estimating the value to society of wetland and riparian zones. It acts to capture the economic values of benefits wetlands provide and to support the wise use of wetland resources. As many goods and services

wetlands provide cannot be normally traded on open markets, non-market valuation approaches are desired to complete an economic valuation process.

The theoretical foundation of wetland and riparian valuation is explored in Chapter 3. It is revealed that since many of the benefits wetlands support are non-marketable, they are often ignored and undervalued in development decisions. The failure to fully account for the value of wetlands by the current market is usually deemed as a major factor of wetland resource degradation and misallocation. The theoretical analysis conducted in Chapter 3 investigates the primary reasons valuation is incomplete, which could be summarized as public goods nature of wetland, poorly defined property rights, limited knowledge and externalities. A graphical model is then introduced to present the basic framework of wetland conservation and conversion activities, and explain why the suboptimal land allocation is caused by the market failure. Monetary incentives can be used as a form of government participation in solving the misallocation problem and achieving wetland conservation goals.

To inform the development of appropriate policy to conserve wetland and riparian areas, Chapter 4 develops an analysis to quantify the cost of conserving wetland and riparian zones from the landowners' perspective. Using data from a mail out stated preference survey to two Saskatchewan study regions, landowners' WTA was estimated representing the levels of economic incentives required for landowners to adopt management practices that conserve wetlands and riparian areas on their private lands. Based on the discrete choice random utility theory, the landowners will only accept the offer if they receive higher utility from participating in the economic incentives program rather than maintaining the status quo. Besides the magnitude of the incentive payment, conservation program participation decisions are also influenced by other characteristics of the farm and landowner.

Finally, Chapter 5 reported the results and empirical analysis of the Saskatchewan landowners' survey. Rather than ignoring the results from those respondents' who did not respond to the WTA question, this study develops two discrete choice models. The binary probit model considers only yes and no responses

while the multinomial probit model takes the responses of the non-respondents into account as well. Both models have been examined due to the fact that a considerable proportion of the returned surveys (40 percent) did not complete the WTA question. This analysis helps to identify the characteristics of farmers who positively, negatively or did not respond to the WTA question.

Both models produce significant coefficient estimates for the magnitude of the payment variable and reveal, as expected, the likelihood of agreeing to participate in the wetland conservation program increases with the level of incentive payment. The probability of a “yes” response increased by 0.6 percent to 0.8 percent with a marginal (\$1) increase in the payment rate. The average WTA compensation required by the respondents was \$30.48/acre. Respondents willing to participate in the program required a higher average payment of \$32.58/acre compared to the non-respondents group of \$28.67/acre and unwilling respondents of \$25.58/acre.

As reflected by the findings from the two probit models developed, past experience dealing with wetlands is found to be a significant factor in predicting landowners’ participation in wetland conservation practices. It is important to note that it did not seem to matter if the previous experience with wetlands involved wetland conservation or wetland drainage. This result seems to highlight the importance of wetland knowledge in the conservation decision process. Some perceptions about the value of wetlands were also revealed to have an important influence on landowners’ decisions. However, only those opinions that were correlated with real economic benefits seemed to have an impact on landowners’ actions. Farm and demographic factors did not appear to have a significant impact on participation decisions except the HEIR variable (the landowner has a child or relative to take over farm management when they retire). The significance of the heir variable indicates that the landowner would be more likely to accept the program offer if the management plan is long-term. The 10 year wetland conservation contract that is proposed in the survey caters to the need of the landowner while ensuring the annual payment. The multinomial probit model evaluates landowners who do not complete the WTA question as well. The

result further confirms that past relative experience and knowledge about wetlands is critical for landowners to give definite answers. The result also suggests that the age of the farmer and the agricultural region in which the farm is located are factors that affect to the provision of an explicit answer. Besides the characteristic factors discussed above, the general comments provided by the survey respondents also indicated that changed personal status (e.g. retirement, farm sale, etc.) and too much water the year the survey was conducted are important causes of uncertainty.

## **6.3 Management Implications**

### ***6.3.1 Targeting Strategy***

With limited public funds, policy strategy should be designed on the basis of the cost-effective principle and target resources which yield the greatest environmental amenities (Wu, et al., 1997 & 2001; Belcher, 2008). Therefore, it is unlikely that any one policy would be efficient for all wetland owners. For conservation purposes, individual landowner's costs would range widely depending on land potential for future use, wetland location, difficulty and cost of conservation and so on (Heimlich et al, 1998). The appropriate economic incentive payment amount in Saskatchewan was found out to be landowners' willingness to participate in conserving and enhancing wetland habitat programs. However, based on the present research, these were clearly not the only drivers of the landowners' participation decision. Other factors were necessary to motivate higher participation rate. As suggested by this research, a policy that targets landowners with an heir and those who have profound wetland knowledge would tend to yield higher levels of participation and would, therefore, be more likely to produce greater environmental benefits from a given budget. These characteristics may offer policy makers an opportunity to achieve proposed goals through relatively low program costs. In addition, it should be noted that the magnitude of the WTA represents the minimum financial incentive landowners would require to participate. If



environmentally sensitive, but more productivity land, is targeted for the incentive program, the mean WTA payment derived from this study might not be high enough to encourage conservation participation (Lynch et al. 2002).

### ***6.3.2 Various Policy Tools***

Government intervention has been shown to be an appropriate approach, in certain situations, to correct market failures and to maximize social welfare. Economic instruments, such as the payment of financial incentives, represent one example of how a policy tool could be used to encourage wetland conservation practices and to increase public welfare. However, even though financial incentives represent a more flexible tool to increase ecosystem services and enrolling more land, it would be quite costly and ineffective if it is the only policy in use (Cuddington, 2008). In fact there are a host of other policies that could provide conservation payoffs. The significant influence of previous wetland management experience on landowners' decision signifies the important role of information and knowledge. Therefore, other policies such as research and technological innovation may be important to complement economic incentive programs to achieve more effective results. Conservation compatible practices (such as conservation tillage, crop rotation and use of insect-resistant or herbicide-tolerant plants) which usually do not require large conversion costs nor require direct financial assistance from governments may also be encouraged. The increase use of such practices could benefit wetland and wildlife habitats by providing greater upland cover and make the wetland more productive.

## **6.4 Limitation of the study**

One limitation of this study is that it does not include the landowners' potential revenue from wetland conservation activities and the co-benefits that are provided by these activities (e.g. income from carbon trade market). As conservation

program payment provides a stable annual income, the prevailing payment formula is that the compensation payment should cover the foregone profit from production earnings (not development costs) (Lynch et al. 2002). If other revenue from wetland conservation was taken into consideration, it is possible program costs could be reduced further to some extent since those incomes could partially offset the opportunity cost of the land subject to wetland and riparian conservation. For example, Cuddington (2008) showed that combining the payments from the carbon market could decrease costs of a wetland and riparian conservation program payments by up to 20 percent depending on the price of carbon.

Determination of an effective economic incentive payment is confined by practical limitation since a relatively small number of observations and low response rate restricts the inference that can be drawn from the analysis. Even though the sample was compared to Census of Agriculture data and was broadly representative of landowners of the larger population, examination of surveys from about two hundred respondents might not be complete enough to make implication about all landowners in PPR. The response rate is expected to be better if not implemented during the harvest season. Likewise, the limitation of examining wetland conservation practices in two agricultural regions limits the applicability of the results. Studies could be conducted over different landscapes to capture the impact of various biological characteristics such as climate, soil productivity and precipitation. This will help effectively target the allocation of wetland and riparian resources.

## **6.5 Future Research**

There are many opportunities for future research of policies for wetland conservation. Firstly, the economic incentive-based policy that the current study examines is a general category of policy and could be further divided into several subcategories such as cost-share incentive payment, land retirement program and environmental tax. Though all of these programs are economic incentive policies, they

will differ in the incentive, participation manner and impact on farms. Investigation of a broader scope of wetland policies could help identify and understand the differences and assist in delivering effective policies.

Wetland quality determines the function and variety of ecological services provided and therefore requires equivalent attention when wetland conservation policies are established. According to Heimlich et al (1998), wetland quality is usually measured by its hydrologic functions, nutrient supply functions, plant community characteristics and dynamics and faunal community characteristics. Understanding the relationship between wetland quality and its functions would assist decision makers to better target wetlands that yield greater environment benefits with fixed budget. This information would also be important to landowners who are expecting greater financial incentives to implement environmental friendly management practice and protect wetlands and surrounding riparian areas, since production activities on surrounding vegetation might also contribute to wetland function degradation. Future research is needed to examine the influence of wetland quality on conservation program targeting strategy and the potential related costs involved.

Lastly, wetland valuation research should be investigated from all sides of the wetland market. Currently, the majority of economic research has focused on quantifying society's valuation of the goods and services wetlands provide from the demand side of the market using valuation study to estimate society's WTP. However, valuation from the supply side may be much more important due to its decisive role in wetland quantity and quality management and thus, there should be more work to develop it. This research looks at the cost of supplying wetland services from the landowners' perspective based on the adoption of the conservation program, which is a less well researched area of wetland markets. But due to limitation of data and scope, further research is needed for a more comprehensive picture of quantification of wetland non-market values.

## REFERENCE

- Agriculture and Agri-Food Canada. (AAFC). (2008a). National Farm Stewardship Program.  
<http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1173969168670&lang=e>  
Reviewed: Feb. 2008
- Agriculture and Agri-Food Canada. (AAFC). (2008b). Agricultural Policy Framework.  
<http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181580600540&lang=e>  
Reviewed: Feb. 2008
- Agriculture and Agri-Food Canada. (AAFC). (2004). Riparian buffers.  
[www.agr.gc.ca/pfra/land/riparian\\_e.htm](http://www.agr.gc.ca/pfra/land/riparian_e.htm)  
Reviewed: Feb. 2008
- Alberta Water Council. (2008). Water for life, recommendations for renewal.  
[http://www.albertawatercouncil.ca/Portals/0/pdfs/Renewal\\_Final\\_Report.pdf](http://www.albertawatercouncil.ca/Portals/0/pdfs/Renewal_Final_Report.pdf)  
Reviewed: May 2008
- Amigues, J. P., C. Boulatoff, B. Desaignes, C. Gauthier, and J. E. Keith. (2002). The benefits and costs of riparian analysis habitat preservation: a willingness to accept/willingness to pay contingent valuation approach. *Ecological Economics* 43, pp.17-31.
- Anderson, M., R. Magleby. (1997). Agricultural Resources and Environmental Indicators, 1996-1997. Agriculture Handbook No. 712. Washington, DC: U.S. Department of Agriculture.
- Anderson, S., R. Newell. (2003). Simplified marginal effects in discrete choice models. Resource for the future. Discussion paper 03-38.  
<http://www.rff.org/documents/RFF-DP-03-38.pdf>  
Reviewed: October 2008
- Antle, J., S. Mooney. (2001). Designing efficient policies for agricultural soil carbon

- sequestration. Preliminary version of a chapter published in 2002 in *Agriculture Practices and Policies for Carbon Sequestration in Soil*, J. kimble, editor, CRC press LLC, Boca Raton, FL, pp. 323-336.
- Austen, E., A. Hanson. (2007). An analysis of wetland policy in Atlantic Canada. *Canadian Water Resources Journal*, 32(3), pp.163-178.
- Barbier, E. B., M. Acreman and D. Knowler. (1997). Economic valuation of wetlands: a guide for policy makers and planners. A reprint of the book published by the Ramsar Convention Secretariat in 1997.  
[http://www.ramsar.org/lib/lib\\_valuation\\_e.htm#c2](http://www.ramsar.org/lib/lib_valuation_e.htm#c2)  
Reviewed: January 2008
- Belcher, K.W. (2008). The targeting of Canadian agri-environmental policy: An analysis of suitability. Seminar draft, University of Saskatchewan, Saskatoon, Canada.
- Bernstein, J., J. Cooper, R. Claassen. (2004). Agriculture and the environment in the United States and EU. *Economic Research Service, USDA, U.S.-EU Food and Agriculture Comparisons*, WRS-04-04, pp.66-77.
- Birol, E., K. Karousakis and P. Koundouri. (2006). Using a choice experiment to account for preference heterogeneity in wetland attributes: the case of Cheimaditida wetland in Greece. *Ecological Economics* 60(1). pp. 145-56.
- Blackwell, B. (1995). *Wetlands: A threatened landscape*. Cambridge Ma.: special publication series, Institute of British Geographers
- Bonds, M. H., J. J. Pompe. (2004). Calculating wetland mitigation banking credits: Adjusting for wetland function and location. *Natural Resources Journal*, 43, pp. 961-977.
- Brethour, C. and Klimas, M. (2008). Emissions Trading in Agriculture: A Canadian Perspective, paper presented to the Agriculture, Greenhouse and Emissions Trading Summit, 21-22 April 2008.
- Byrne, J. P. (2004). Property and environment: thoughts on an evolving relationship. Part of the 2004 National Student Federalist Society Symposium on Law and

- Public Policy. Georgetown University Law Center.
- Canada Facts. (2008). Saskatchewan: Location and Land.  
<http://www.educationcanada.com/facts/index.phtml?sid=sk&a=2&lang=eng>  
Reviewed: August 2008
- Canadian Environmental Assessment Agency. (2008). Legislation and Regulations  
[http://www.ceaa.gc.ca/013/index\\_e.htm](http://www.ceaa.gc.ca/013/index_e.htm)  
Reviewed: February 2008
- Carriker, R. R. (1994). Wetlands and environmental legislation issues. *Journal of Agricultural and Applied Economics* 26(1), pp.80-89.
- Cary, J.W., R.L. Wilkinson. (1997). Perceived profitability & farmers' conservation behaviour. *Journal of Agricultural Economics*, 48 (1): pp.13–21.
- Center for Studies in Agriculture, Law and the Environment (CSALE). (2002). Report on Saskatchewan Law and Policy on wetland and upland conservation to Ducks Unlimited Canada, Phase I.
- Claassen, R. L. Hansen, M. Peters, V. Breneman, M. Weinberg, A. Cattaneo, P. Feather, Dwight Gadsby, D. Hellersein, J. Hopkins, P. Johnston, M. Morehart and M. Smith. (2001). Agri-environmental policy at the crossroads: guideposts on a changing landscape. Agricultural Economic Report 794. Economic Research Service, USDA, Washington, D.C.
- Climate Action Network Canada. (2004). Ontario, the federal government and the Kyoto Protocol.  
<http://www.climateactionnetwork.ca/e/publications/ontario-kyoto-2004.pdf>  
Reviewed: January 2008
- Connecticut River Joint Commissions. (2000). Introduction to riparian buffers. Fact sheets in the series riparian buffers for the Connecticut River Watershed. No. 1.
- Convention on Biological Diversity (CBD). (2008a). About the convention.  
<http://www.cbd.int/convention/about.shtml>  
Reviewed: March 2008

- Convention on Biological Diversity (CBD). (2008b). United Kingdom of Great Britain and Northern Ireland-Overview.  
<http://www.cbd.int/countries/?country=gb>  
 Reviewed: March 2008
- Cooper, J. C., R. W. Keim. (1996). Incentive payments to encourage farmer adoption of water quality protection practices. *American Journal of Agricultural Economics* (78), pp.54-64.
- Cox. K. W. (1993). Wetlands: A celebration of life. North American Wetlands Conservation Council (Canada), Sustaining wetlands, Issues paper, No. 1993-1.
- Crosson, P., K. Frederick. (1999). Impacts of federal policies and programs on wetlands. Discussion Paper 99-26, 1616 P street, NW, Washington, DC.
- Cuddington, A. D. (2008). Bio-economic considerations for wetland policy on an agricultural landscape. Unpublished master's thesis, Department of Agricultural Economics , University of Saskatchewan, Saskatoon.
- Davey, K. A. (2006). Minimum tillage adoption: an examination of the Canadian prairie provinces. Unpublished master's thesis. Department of Agricultural Economics, University of Saskatchewan, Saskatoon.
- DeVries, B. (2000). Multifunctional agriculture in the international context: A review. The Land Stewardship Project.  
<http://www.landstewardshipproject.org/mba/MFAReview.pdf>  
 Reviewed: October 2007
- Do, T.N. and Bennett, J. (2007). Willingness to pay for wetland improvement in Vietnam's Mekong River Delta. Australian Agricultural and Resource Economics Society 51<sup>st</sup> Annual Conference
- Ducks Unlimited Canada (DUC). (2006). Wetland restoration accepted as Beneficial Management Practice.  
<http://www.ducks.ca/aboutduc/news/archives/2006/060111.html>  
 Reviewed: February 2008

Ducks Unlimited Canada (DUC). (2008). NAWMP-North American Waterfowl Management Plan.

<http://www.ducks.org/Conservation/GovernmentAffairs/1623/NAWMP.html>

Reviewed: February 2008

Economic Research Service (ERS). (1998). Agriculture & wetlands: Is “No net loss” achievable? Agricultural Outlook, June-July, 1998. Resource & Environment.

Environment Act of 1994-1995. (2006). Nova Scotia Environment Act. Chapter 1 of the Acts of 1994-1995.

<http://www.gov.ns.ca/legislature/legc/statutes/envromnt.htm>

Reviewed: June 2009

Environment Canada. (2001). Putting an economic value on wetlands-Concepts, Methods and Considerations.

[http://www.on.ec.gc.ca/wildlife/factsheets/fs\\_wetlands-e.html#8](http://www.on.ec.gc.ca/wildlife/factsheets/fs_wetlands-e.html#8)

Reviewed: February 2008

Environment Canada. (2008). Great lakes wetland conservation action plan.

<http://www.on.ec.gc.ca/wildlife/wetlands/glwcap-e.cfm>

Reviewed: December 2007

Environment Canada. (2009). Canadian Climate Normals or Averages 1971-2000.

[http://www.climate.weatheroffice.ec.gc.ca/climate\\_normals/index\\_e.html](http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html)

Reviewed: March 2009

Environmental Law Institute (ELI). (2008). Profile: Jessica Wilkinson speaks out on mitigation banking.

[http://www.eli.org/Program\\_Areas/mitigation\\_interview.cfm](http://www.eli.org/Program_Areas/mitigation_interview.cfm)

Reviewed: March 2008

Environmental Protection Agency (EPA). (2001). Threats to wetlands.

<http://www.epa.gov/owow/wetlands/pdf/threats.pdf>

Reviewed: March 2008

European Commission. (2003). Agriculture and the environment. Fact sheet.

[http://ec.europa.eu/agriculture/publi/fact/envir/2003\\_en.pdf](http://ec.europa.eu/agriculture/publi/fact/envir/2003_en.pdf)



Reviewed: November 2007

European Commission. (2007). Life and Europe's wetlands. Restoring a vital ecosystem.

<http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/documents/wetlands.pdf>

Reviewed: May 2008

Farnese, P.L. and K.W. Belcher. (2006). Wetlands in agricultural landscapes: a legal and policy context. *Law, Science and Policy* Vol. 3, pp.33-58.

Feder, G., Just, R. E., and Zilberman, D. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change*, 33(2), pp.255-298.

Ferguson, M. A. (2005). Demographic change and sustainable communities: the role of local factors in explaining population change. Unpublished master's thesis, Department of Agricultural Economics, University of Saskatchewan, Saskatoon.

Gedikkoglu, H., L. McCann. (2007). Impact of off-farm income on adoption of conservation practices. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR.

Gelso, B.R., Fox, J.A. and Peterson, J.M. (2008). Farmers' perceived costs of wetlands: Effects of wetland size, hydration, and dispersion. *American Journal of Agricultural Economics* 90: pp.172-185.

Government of Canada. (1991). The federal policy on wetland conservation. Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.

Government of Saskatchewan. (1999). Water management framework. Government of Saskatchewan.

Greene, W. H. (2003). *Econometric Analysis*. Pearson Education, Inc., New Jersey pp. 663-755.

Grose, A., R.O. Bailey and K.W. Cox. (2000). Wetland mitigation in Canada. In Cox, K.W. and A. Grose (Eds). *Wetland mitigation in Canada: A Framework for*

- Application. Sustaining Wetland Issues Paper 2000-1. Secretariat to the North American Wetlands Conservation Council (Canada). Ottawa, ON, 1-14.
- Hanemann, W. M. (1984). Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics* 66, pp.332-341.
- Hanemann, W. M. (1994). Valuing the environment through contingent valuation. *Journal of Economic Perspectives*, vol. 8, issue 4, pp.19-43.
- Hansen, L. (2007). Restoration of wetland services: economic gains to the farmland owner. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR.
- Heimlich, R. E., K. D. Wiebe, R. Claassen, D. Gadsby, and R. M. House. (1998). Wetlands and agriculture: Private interests and public benefits. *USDA, Economic Research Service, Agriculture Economic Report* Number 765.
- Hogan, J.M. and F.M. Conly. (2002). St. Denis National Wildlife Area Land Cover Classification: 1997. Technical Report Series No. 384, Canadian Wildlife Service, Prairie and Northern Region, Saskatoon, SK, Canada.
- Hua W., Zulauf, C., and Sohngen, B. (2004). To Adopt or Not to Adopt: Conservation Decisions and Participation in Watershed Groups. Selected Paper for Presentation at the American Agricultural Economics Association Annual Meeting, Denver, Colorado.
- Huel, D. (2000). Managing Saskatchewan Wetlands ~ A landowner's Guide. Saskatchewan Wetland Conservation Corporation.
- Irwin, E. G. (2002). The effects of open space on residential property values. *Land Economics*, 78(4), pp.465-480.
- Jehle, G. A. and P.J. Reny. (2001). Advanced microeconomic theory. Second ed. The Addison-Wesley series in economics. pp. 117-154.
- Johnson, P.M. (2003). A Glossary of Political Economy. Institute for Socio-Economic and Political Studies, Penerbit TERAJU, Jakarta, Indonesia.
- <http://www.auburn.edu/~johnspm/gloss/externality>

Reviewed: February 2009

Jones, W. D., I. A. Munn, S. C. Grado, J. C. Jones. (2001). Fee hunting: An income source for Mississippi's Nonindustrial, private landowners. FWRC Research Bulletin Number F0164.

Kazmierczak, R. F. (2001). Economic linkages between coastal wetlands and hunting and fishing: a review of value estimates reported in the published literature. Staff paper 2001-03, Department of Agricultural Economics & Agribusiness, Louisiana State University Agricultural Center, Baton Rouge, Louisiana.

King, D.M. and M.J. Mazzotta. (2000). Ecosystem Valuation.

<http://www.ecosystemvaluation.org/>

Reviewed: February 2008

Kingsbury, L., W. Boggess. (1999). An economic analysis of riparian landowners' willingness to participate in Oregon's conservation reserve enhancement program. Selected paper for the annual meeting of the American Agricultural Economics Association.

Kline, J. D., R. J. Alig, R. L. Johnson. (2000). Forest owner incentives to protect riparian habitat. *Ecological Economics*, 33, pp. 29-43.

Lambert, A. (2003). Economic valuation of wetlands: an important component of wetland management strategies at the river basin scale. Ramsar Convention.

[http://www.ramsar.org/features/features\\_econ\\_val1.htm](http://www.ramsar.org/features/features_econ_val1.htm)

Reviewed: January 2008

Lambert, D., P. Sullivan, R. Claassen, and L. Foreman. (2006). Conservation-compatible practices and programs: who participates? *USDA, Economic Research Service, Economic Research Report Number 14*.

Lee, M. (2006). Environmental Economics: A market failure approach to the commerce clause. *The Yale Law Journal*.

<http://www.yalelawjournal.org/pdf/116-2/Lee.pdf>

Reviewed: October 2008

Lichtenberg, E. (2000). Agriculture and the environment. Working paper No. 00-15

<http://ageconsearch.umn.edu/bitstream/28567/1/wp00-15.pdf>

Reviewed: October 2007

Lynch, L., I. Hardie, D. Parker. (2002). Analyzing agricultural landowners' willingness to install streamside buffers. Working paper 02-01. Department of Agriculture and Resource Economics, University of Maryland, College park.

Lynch-Stewart, P, P. Niece, C. Rubec and I. Kessel-Taylor. (1996). The federal policy on wetland conservation: implementation guide for federal land managers. Environment Canada, Ottawa.

Lynch-Stewart, P., I. Kessel-Taylor and C. Rubec. (1999). Wetlands and government: Policy and legislation for wetland conservation in Canada. North American Wetlands Conservation Council (Canada), No. 1999-1.

Manitoba Wildlands. (2008). Manitoba water initiatives.

[http://www.manitobawildlands.org/water\\_mb.htm](http://www.manitobawildlands.org/water_mb.htm)

Reviewed: April 2008

Mclemore Mitigation Bank. (2008). <http://mclemoremitigationbank.com/rates.html>

Reviewed: March 2008

Mitra, S., R. Wassmann, P. L. G. Vlek. (2003). Global inventory of wetlands and their role in the carbon cycle. ZEF – Discussion papers on development policy no. 64, Center for Development Research, Bonn, pp. 44.

National Wetlands Working Group. (1988). Wetlands of Canada. Ecological Land Classification Series, No. 24. Sustainable Development Branch, Environment Canada, and Polyscience Publications Inc. Ottawa, Ontario.

Natural Resources Canada. (2004). Wetlands.

[http://atlas.nrcan.gc.ca/site/english/learningresources/theme\\_modules/wetlands/index.html](http://atlas.nrcan.gc.ca/site/english/learningresources/theme_modules/wetlands/index.html)

Reviewed: December 2007

Natural Resource Canada. (2007). Prairie wetland regions.

<http://wetlands.cfl.scf.nrcan.gc.ca/regions/prairies-eng.asp>

Reviewed: May 2008

- Norris, A., P. Ahern and T. Koontz. (1994). Wetland regulation impacts on agricultural land prices in two Oklahoma countries. Selected paper presented at Southern Agricultural Economics Association meeting.
- North American Waterfowl Management Plan (NAWMP). (2008). What is the North American Waterfowl Management Plan (NAWMP)?  
<http://www.nawmp.ab.ca/background.html>  
Reviewed: February 2008
- NRCS. (2008). Wetland policy/Procedures overview. Section 404, Clean Water Act.  
<http://www.mt.nrcs.usda.gov/technical/ecs/biology/wetlandpolicy.html>  
Reviewed: November 2007
- NRCS Farm Bill 2002. (2007). Wetland Reserve Program. Fact sheet.  
[http://www.nrcs.usda.gov/programs/wrp/2007\\_ContractInfo/2007WRPFactSheet.pdf](http://www.nrcs.usda.gov/programs/wrp/2007_ContractInfo/2007WRPFactSheet.pdf)  
Reviewed: January 2008
- Ramsar. (2007). The Ramsar Convention on Wetlands.  
<http://www.ramsar.org/>  
Reviewed: December 2007
- Ramsar. (2009a). The Ramsar Convention on Wetlands.  
<http://www.ramsar.org/>  
Reviewed: April 2009
- Ramsar. (2009b). Contracting parties to the Ramsar convention on wetlands  
[http://www.ramsar.org/key\\_cp\\_e.htm](http://www.ramsar.org/key_cp_e.htm)  
Reviewed: May 2009
- Ramsar Convention Secretariat. (2007). Wise use of wetlands: A conceptual framework for the wise use of wetlands. Ramsar Handbook for the wise use of wetlands, 3<sup>rd</sup> edition, vol. 1. Ramsar Convention Secretariat, Gland, Switzerland.
- Ramsar Forum. (1998). “No net loss” and mitigation banking. Posted to Ramsar Forum, 12-15 May, 1998.

[http://www.ramsar.org/forum/forum\\_mitigation.htm](http://www.ramsar.org/forum/forum_mitigation.htm)

Reviewed: April 2008

Ramsar Information Bureau. (1998): Report of Allocations 1992-97, The Ramsar Convention Small Grants Fund. Ramsar, Gland, Switzerland,  
<http://www.iucn.org/themes/Ramsar>

Reviewed: November 2007

Ramsar Information Bureau. (2007a). What are wetlands? Ramsar Information Paper no. 1. <http://www.ramsar.org/about/info2007-01-e.pdf>

Reviewed: November 2007

Ramsar Information Bureau. (2007b). What is the Ramsar Convention on Wetlands? Ramsar Information Paper no. 2.

<http://www.ramsar.org/about/info2007-02-e.pdf>

Reviewed: November 2007

Rogue Wave Software. (1999). 4.2 Model selection viewed as search. Online documentation.

<http://www2.roguewave.com/support/docs/hppdocs/anaug/4-2.html>

Reviewed: October 2008.

Rubec, C.D.A., A. R. Hanson. (2008). Wetland mitigation and compensation: Canadian experience. Springer Science + Business Media, Wetlands Ecol Manage.

Saskatchewan Agriculture and Food (SAF). (2006). *2005 private lease rate survey for cultivated and pasture land*. Finance – StatFact 12.13. Policy Branch, SAF, Regina, SK.

[www.agr.gov.sk.ca](http://www.agr.gov.sk.ca).

Reviewed: May 2009

Saskatchewan Watershed Authority (SWA). (2007). 2007-2008 Saskatchewan provincial budget. Performance plan.

Saskschools. (2008). Saskatchewan climate and weather forecasts.

<http://www.saskschools.ca/~gregory/sask/climate.html>

Reviewed: September 2008

- Schuyt K. and L. Brander. (2004). The economic values of the world's wetlands. Prepared with support from the Swiss Agency for the Environment, Forests and Landscape (SAEFL). Gland/Amsterdam.  
<http://assets.panda.org/downloads/wetlandsbrochurefinal.pdf>  
Reviewed: August 2008
- Shabman, L. and P. Scodari. (2004). Past, present and future of wetlands credit sales. Discussion paper 04-48.  
<http://www.nceep.net/pages/RFF-DP-04-48.pdf>  
Reviewed: February 2008
- Shaikh, S. L., L. Sun, G. C. van Kooten. (2007). Are agricultural values a reliable guide in determining landowners' decisions to create forest carbon sinks? *Canadian Journal of Agricultural Economics*, 55, pp. 97-114.
- Sibbing, J.M. (2008). Nowhere near no-net-loss. National Wildlife Federation.  
<http://www.nwf.org/wildlife/pdfs/NowhereNearNoNetLoss.pdf>  
Reviewed: June 2008
- Southam, T., A. Curran, E. Ansley. (1996). The Wetlandkeepers Handbook: A practical guide to wetland care. British Columbia: Fisheries and oceans Canada, Habitat and Enhancement Branch, Province of B.C., Ministry of Environment, Lands and Parks.
- Sparling, B., C. Brethour. (2007). An economic evaluation of beneficial management practices for crop nutrients in Canadian agriculture. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR.
- Sprung, J. (1999). An analysis of landowner attitudes and behavior regarding North American waterfowl management plan leases in Southwestern Manitoba. Unpublished master's thesis, Natural Resources Institute, University of Manitoba, Winnipeg.
- Statistics Canada. (2006a). 2006 Agricultural Community Profiles  
<http://www26.statcan.ca:8080/AgrProfiles/cp06/Table1.action?prov=47&sear>

ch=search&placename=st-denis&placestart=0&geog\_id=478115014&geog\_id\_amal=478115014&loccode=27086&tab\_id=1

[http://www26.statcan.ca:8080/AgrProfiles/cp06/Table1.action?prov=47&search=search&placename=enfield+no.+194&placestart=0&geog\\_id=473007053&geog\\_id\\_amal=473007053&loccode=29687&tab\\_id=1](http://www26.statcan.ca:8080/AgrProfiles/cp06/Table1.action?prov=47&search=search&placename=enfield+no.+194&placestart=0&geog_id=473007053&geog_id_amal=473007053&loccode=29687&tab_id=1)

Reviewed: May 2008

Statistics Canada. (2006b). Snapshot of Canadian agriculture.

<http://www.statcan.gc.ca/ca-ra2006/articles/snapshot-portrait-eng.htm#3>

Reviewed: November 2008

Statistics Canada. (2006c). Agriculture farms and farm operators.

[http://cansim2.statcan.ca/cgi-win/cnsmcgi.pgm?Lang=E&SP\\_Action=Result&SP\\_ID=1637&SP\\_TYP=5&SP\\_Sort=1](http://cansim2.statcan.ca/cgi-win/cnsmcgi.pgm?Lang=E&SP_Action=Result&SP_ID=1637&SP_TYP=5&SP_Sort=1)

Reviewed: November 2008

Swinton, S. M., F. Lupi, G.P. Robertson, S.K. Hamilton. (2007). Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits. *Ecological Economics* 64. pp. 245-252.

Tapsuwan, S., G. Ingram, D. Brennan. (2007). Valuing urban wetlands of the Gngangara Mound: a hedonic property price approach in western Australia. Prepared for the Australian Agricultural and Resource Economics Society 51<sup>st</sup> Annual Conference.

The Encyclopedia of Saskatchewan. (2008). *Soils*.

<http://esask.uregina.ca/entry/soils.html>

Reviewed: August 2008

Train, K. E. (2003). Discrete Choice Methods with Simulation (pp. 15-21). Cambridge: Cambridge University Press.

Tyrvaainen L. and A. Miettinen. (2000). Property prices and urban forest amenities. *Journal of Environmental Economics and Management* 39, pp. 205-233.

UCLA Academic Technology Services. (2008). Stata Annotated Output Probit Regression, UCLA: Academic Technology Services, Statistical Consulting



Group

[http://www.ats.ucla.edu/stat/Stata/output/Stata\\_Probit.htm](http://www.ats.ucla.edu/stat/Stata/output/Stata_Probit.htm)

Reviewed: November 2008

United Nations Framework Convention on Climate Change (UNFCCC). (2008).

[http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php)

Reviewed: March 2008

United States National Ramsar Committee. (USNRC). (2008).

<http://www.ramsarcommittee.us/index.asp>

Reviewed: March 2008

Upadhyay, B. M., Young D. L., Wang H. H., and Wandschneider, P. (2002). How Do Farmers Who Adopt Multiple Conservation Practices Differ From Their Neighbors? Selected Paper for Presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 28-31.

Van Kooten, G.C., S. Shaikh, P. Suchanek. (2002). Mitigating climate change by planting trees: the transaction costs trap. *Land Economics*, 78.4, pp. 559-572.

Virtual Saskatchewan. (2008). Interactive ecoregions map.

<http://www.virtualsk.com/maps/index.html>

Reviewed: July 2008

Washington Department of Ecology. (2006). Status of the wetland mitigation banking pilot program. December, 2006 status report. Olympia, Washington 98504-7710

Washington State Department of Ecology (WSDE). (2008). Wetland mitigation banking.

<http://www.ecy.wa.gov/programs/sea/wetlands/mitigation/banking/index.html>

Reviewed: January 2008

Whitten, S. M. (2003). Provision of environmental goods on private land: a case study of Australian wetlands. Unpublished Ph.D's thesis, School of Economics and Management, The University of New South Wales.

Wiebe, K. and N. Gollehon. (2006). Agricultural resources and environmental

- indicators, 2006 edition. USDA, Economic Information Bulletin 16.
- Wiken, E. B., D. Gauthier, I. Marshall. K. Lawton and H. Hirvonen. (1996). A Perspective on Canada's Ecosystems: An Overview of the Terrestrial and Marine Ecozones. Canadian Council on Ecological Areas (CCEA). Occasional Paper No. 14. Ottawa, Ontario.
- Wiken, E., J. C. Mars, M. Padilla, H. Moore, and C. Latsch. (2003). The state of Canadian wetlands. Background paper prepared for the national conference on Canadian wetlands.
- Wildfow & Wetland Trust (WWT). (2008). Wetland conservation-legislation and responsibilities.  
<http://www.wwt.org.uk/uploads/legislation.pdf>  
 Reviewed: June 2008
- Wu, J.J., D. Zilberman and B.A. Babcock. (2001). Environmental and distributional impacts of conservation targeting strategies. *Journal of Environmental Economics* (41): pp. 333-350.
- Wu, J.J., D. Zilberman, B.A. Babcock and P.G. Lakshminarayan. (1997). Targeting tools for the purchase of environmental amenities. *Land Economics*. 73(3): pp. 325-39.
- Wu, J.J., K.S. Groth. (2002). Targeting conservation efforts in the presence of threshold effects and ecosystem linkages. *Ecological Economics* 42, pp. 313-331.
- Wu, J.J., M. R. Adams and W.G. Boggess. (2000). Cumulative effects and optimal targeting of conservation efforts: Steelhead trout habitat enhancement in Oregon. *American Journal of Agricultural Economics* (82). pp. 400-413.
- World Wildlife Fund (WWF). (2008). Wetlands under threat. WWF living Water Campaign.  
[assets.panda.org/downloads/WETTHREATSENG.doc](http://assets.panda.org/downloads/WETTHREATSENG.doc)  
 Reviewed: January 2008
- Wylynko, D. (1999). Prairie wetlands and carbon sequestration—Assessing sinks

under the Kyoto Protocol. International Institute for Sustainable Development (IISD) Winnipeg, Canada, pp.45

Zellner, D., F. Keller, G.E. Zellner. (2004). Variable selection in logistic regression models. Communications in statistics, simulation and computation, Vol. 33, No. 3, pp. 787-805.

## APPENDIX A—SURVEY

### Letter of Invitation



Department of Agricultural Economics  
51 Campus Drive, Saskatoon, SK  
S7N 5A8 Canada  
Telephone: (306) 966-4008  
Fax: (306) 966-8413

July 2007

#### Dear Producers;

You are invited to participate in a study entitled "Economic, Greenhouse Gas and Policy Implications of Riparian Management on an Agricultural Landscape". Please read this letter carefully and feel free to ask any questions that you might have.

The purpose of the research is to determine the costs and benefits of implementing beneficial management practices (BMPs) that improve the quantity and quality of riparian areas and natural corridors on agricultural landscapes. Your responses will help us to determine a pattern of program delivery that is cost effective and will be attractive to farmers. It is expected that the survey should last between 10 - 15 minutes.

This research is funded by Ducks Unlimited Canada in conjunction with Advancing Canadian Agriculture and Agri-Food which is an organization dedicated to finding policy solutions that directly benefit Canadian farmers and the agriculture and agri-food industry. The research conclusions will be published in a variety of formats, both print and electronic. These materials may be further used for purposes of conference presentations, or publication in academic journals, books or popular press.

Participation in this survey poses no personal risk. Data and information provided by surveys will be reported in an aggregate form that protects the confidentiality and the anonymity of individual participants. In principle, actual names will not be used. The survey data will be securely stored by the Research Advisor, Dr. Ken Belcher, at the Department of Agricultural Economics for a period of five years. This information will only be available to the researchers for the purpose of this study. Your participation is completely voluntary and you may withdraw from the study for any reason, at any time, without penalty. You may also refuse to answer individual questions. Return of the survey questionnaire to the Researcher's indicates your consent to participate in this study.

If you have any questions concerning the study, please feel free to ask at any point by contacting the Researchers at the numbers provided below. This study has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board on June 26<sup>th</sup>, 2007. Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (306-966-2084). Out of town participants may call collect.

To thank you for participating in this survey we invite you to enter into a prize draw of your choice for a handheld GPS, or Satellite Radio system. Entry into the prize draw is completely optional. The lottery draw form will be stored separately from the survey, further preventing the identification of individual participants responses.

#### Researchers:

Ms. Amber Cuddington  
Center for Studies in Agriculture,  
Law & the Environment  
University of Saskatchewan  
(306) 966-1692

Ms. Mandy Yu  
Dept. of Agricultural Economics  
University of Saskatchewan  
(306) 966-4034

Dr. Ken Belcher  
Dept. of Agricultural Economics  
University of Saskatchewan  
(306) 966-4019

# Survey Questionnaire



## UNIVERSITY OF SASKATCHEWAN

### Economic, Greenhouse Gas and Policy Implications of Riparian Management on an Agricultural Landscape

#### Researchers

Amber Cuddington (306) 966-1692

Mandy Yu (306) 966-4034

Ken Belcher (306) 966-4019

Department of Agricultural Economics, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, S7N 5A8

#### How to Complete this Questionnaire

- Please read through the letter of invitation prior to completing the questionnaire.
- Please ensure that only 1 questionnaire is completed for each agricultural operation.
- Gray text indicates directions to answering the question or direction to the next questions to be answered.

- When answering the questionnaire please consider only the practices related to the land that was operated by you in 2006, do not report on land that you rented or leased to others.
- Definitions of important terms are included on the back page. If a definition is provided it will be indicated in the text by a superscripted number (example: conventional tillage<sup>1</sup>).
- Fill out the questionnaire using a black or blue pen.
- Enter a number in a box ,example: 

1	2	3	4
---	---	---	---
- Fill in a box , example: ☒ or ☒
- Print on a line, example: cultivator

#### Once Completed

- If you are satisfied with your responses please mail the completed questionnaire in the provided postage paid envelope, return of the prize draw entry form is optional.
- If you have any questions, comments or concerns please contact the researchers.
- **Your responses are strictly confidential and will be used only for statistical purposes.**

#### Part I. General

##### Question 1

What RM is your farm located in? RM# \_\_\_\_\_

##### Question 2

Is the cropping portion of your farm certified organic?

- ☐ Yes
- ☐ Partially, what proportion? \_\_\_\_\_ %
- ☐ No

##### Question 3

What type of farm operation do you have?

- ☐ Grain
- ☐ Mixed Grain & Cattle, Grain \_\_\_\_\_ % Cattle \_\_\_\_\_ %
- ☐ Other (Specify) \_\_\_\_\_

#### Part II. Cropping & Land Use Information

##### Question 4

What is a typical 5 year crop rotation or any given field on this farm? (If you commonly use 2 different rotations include both, for example one commercial rotation and one seed production rotation)

Year 1	Year 2	Year 3	Year 4	Year 5
_____	_____	_____	_____	_____

##### Question 5

Approximately how much area was dedicated to each of the following crop types in 2006?

Cereals	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Pulses	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Oilseeds	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Tame Hay/Silage	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Other, _____	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres

##### Question 6

What type of tillage practice did you use on this farm in 2006?

- ☐ Conventional Tillage<sup>1</sup>
- ☐ Conservation Tillage<sup>2</sup>, year implemented \_\_\_\_\_
- ☐ Zero-tillage<sup>3</sup>, year implemented \_\_\_\_\_

##### Question 7

Approximately how much area was dedicated to each of the following land uses in 2006?

	Owned	Rented or Leased											
Cropped	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Summerfallow <sup>4</sup>	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Tame Forage <sup>5</sup>	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Native Pasture <sup>6</sup>	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Woodlands <sup>7</sup>	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Wetlands & Riparian Arcas <sup>8</sup>	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres
Permanent Veg. Corridor <sup>9</sup>	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						<table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Acres

##### Question 8

What kind of tractor and implement do you typically use for the following management practices? (If you apply fertilizer at seeding please indicate this in the fertilizer row)

	Tractor HP	Implement	Width (ft)												
Seeding	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>				
Tillage	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>				
Fertilizer	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>				
Pesticides	<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					<table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>				

### Part III. Wetland & Riparian Management

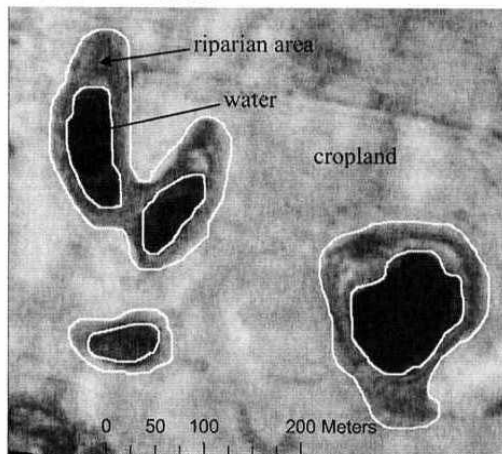
**Definition Riparian Area** - Permanent vegetation (including native species, tame forages and shrubs) that is adjacent to any body of water (permanent<sup>10</sup> or seasonal<sup>11</sup>) – see photo below.

#### Question 9

We are investigating the feasibility of a riparian management program aimed at restoring and maintaining riparian zones in the agricultural regions of Western Canada. The proposed program would provide financial and technical assistance to farmers who provide permanently vegetated riparian zones around wetlands (minimum 10 meters or 32 feet wide) within agricultural fields. The proposed program would consist of a 10 year contract that provides landowners with an annual payment based on the area of land allocated to riparian vegetation. At the end of the contract period the landowner could choose to renew the contract or exit the program. For the duration of the contract the subject riparian zone could not be cultivated or cropped, however, the areas could be managed for haying or grazing at pre-determined times during the growing season. If the area is disturbed by cultivation or cropping during the contract period the landowner would be responsible for reimbursing the program payment.

The program would provide farmers with an annual \$40 per acre payment based on the area that is allocated to permanent riparian vegetation. Would you accept this program payment to restore and/or maintain riparian areas around wetlands on your land?

☐ Yes ☐ No



Example of an agricultural field with effective riparian areas.

#### Question 10

Have you drained/cultivated wetlands or pushed-bush on your farm within the last 10 years?

☐ Yes ☐ No

#### Question 11

Do you plan to drain/cultivate wetlands or push-bush on your farm land within the next 5 years?

#### Question 12

Do you maintain a riparian area surrounding water bodies that hold water throughout the summer in most years (ie. permanent wetlands<sup>10</sup>)?

☐ Yes → Minimum Width \_\_\_\_\_ ☐ feet ☐ meters  
☐ No

#### Question 13

Do you maintain a riparian area surrounding water bodies that hold water until mid-May in most years (ie. seasonal wetlands<sup>11</sup>)?

☐ Yes → Minimum Width \_\_\_\_\_ ☐ feet ☐ meters  
☐ No

#### Question 14

Please indicate the level to which you agree with the following statements: (A=Agree; N=Neutral; D=Disagree)

	A	N	D
Riparian areas harbor undesirable pests .....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are pleasing to look at .....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are important for erosion control. ....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas reduce farm productivity.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are important for water quality....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are important for flood control....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are costly to maintain.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are important for wildlife.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Riparian areas are difficult to maneuver around with farm equipment.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The benefits of wetlands and riparian zones outweigh the disadvantages.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Part IV. Farm Planning

#### Question 15

Do you have a defined farm management plan for your farm?

☐ Yes ☐ No (If no, please proceed to question 18)

#### Question 16

What components does your farm management plan address? (check all that apply)

- ☐ Crop rotation
- ☐ Fertilizer use
- ☐ Pesticide use
- ☐ Budget

#### Question 17

How long does your plan extend?

- ☐ Less than five years
- ☐ 5-10 years
- ☐ Greater than 10 years.

#### Question 18

Have you conducted an Environmental Farm Plan<sup>12</sup> (EFP)?

☐ Yes ☐ No (If no, please proceed to question 24)

#### Question 19

Why have you chosen to complete an EFP?(check all that apply)

- ☐ Interest in the Environment
- ☐ To access funding
- ☐ Believe they will be mandatory in the future
- ☐ Encouragement from other farmers/neighbors

**Question 20**

When was your EFP developed or last updated?

- ☐ Less than 1 year ago  
☐ 1-5 years ago  
☐ More than 5 years ago

**Question 21**

To what extent have you implemented beneficial management practices<sup>13</sup> (BMPs) outlined in your EFP?

- ☐ Fully implemented  
☐ Partially implemented  
☐ Not implemented

**Question 22**

Have you received any technical assistance to help implement BMPs? (check all that apply)

- ☐ No  
☐ Yes, from a government agency  
☐ Yes, from a private industry agency  
☐ Yes, from a private environmental/conservation agency  
☐ Yes, from other, specify \_\_\_\_\_

**Question 23**

Have you received any financial assistance to offset the costs of implementing BMPs?

(check all that apply then proceed to question 26)

- ☐ No  
☐ Yes, from a government agency  
☐ Yes, from a private industry agency  
☐ Yes, from a private environmental/conservation agency  
☐ Yes, from other, specify \_\_\_\_\_

**Question 24**

If you have not completed an EFP please identify the reasons.  
 (check all that apply)

- ☐ Have never heard of this program  
☐ Have not had time  
☐ Too much paper work involved  
☐ Do not feel a need to manage for the environment  
☐ Disagree with this government program  
☐ Other, specify \_\_\_\_\_

**Question 25**

Do you plan to conduct an EFP in the future?

- ☐ Yes ☐ No

**Part V. Farm Operator Profile****Question 26**

How long has the oldest part of your farm been in your family? \_\_\_\_\_ years

Please answer the following questions for EACH PERSON responsible for making management decisions on this farm.

**Operator 1****Question 27**

What is your age? \_\_\_\_\_ years

**Question 28**

How long have you been a decision maker on your farm? \_\_\_\_\_ years

**Question 29**

What is the highest level of education you have received?

- ☐ Primary/Secondary School  
☐ High School Diploma  
☐ College/Journeyman Diploma  
☐ Bachelor's Degree  
☐ Graduate Degree

**Question 30**

Do you have any off-farm income?

- ☐ Yes ☐ No

**Question 31**

How long do you plan to continue farming? \_\_\_\_\_ years

**Question 32**

If you are planning on retiring in the next 10 years will someone in your family take over farm management when you retire?

- ☐ Yes  
☐ No  
☐ Don't know

**Operator 2****Question 33**

What is your age? \_\_\_\_\_ years

**Question 34**

How long have you been a decision maker on your farm? \_\_\_\_\_ years

**Question 35**

What is the highest level of education you have received?

- ☐ Primary/Secondary School  
☐ High School Diploma  
☐ College/Journeyman Diploma  
☐ Bachelor's Degree  
☐ Graduate Degree

**Question 36**

Do you have any off-farm income?

- Yes ☐ No

**Question 37**

How long do you plan to continue farming? \_\_\_\_\_ years

**Question 38**

If you are planning on retiring in the next 10 years will someone in your family take over farm management when you retire?

- ☐ Yes  
☐ No  
☐ Don't know

If there are more than 2 people that make management decisions on your farm please provide their details in the comments section.

**Thank you for taking the time to complete this survey!**

**If you have any additional comments please feel free to provide them in the comments section on the back of this page.**

[illegible]

## Definitions

1. **Conventional Tillage:** Tillage that incorporates most of the crop residue prior to planting (less than 30% of the previous crop's residue remains on the surface after planting). Tillage operations done using implements which turn the soil over such as mouldboard plough or discs.
2. **Conservation Tillage:** Tillage prior to planting that retains most of the crop residue on the surface (30-60% of the previous crop's residue remains on the surface after planting). Tillage operations done using implements which don't turn the soil over such as chisel plow, soil saver...
3. **Zero-Tillage:** No tillage prior to planting (more than 60% of the previous crop's residue remains on the surface after planting). Seeding operations done using implements such as air seeder, air drill or other low disturbance drills or planter.
4. **Summerfallow:** Includes chemfallow.
5. **Tame Forage:** Non-native cover vegetation (grass or legume) that is used for pasture, hay, silage or seed.
6. **Native Pasture:** Permanent native vegetation that is used for livestock grazing or haying.
7. **Woodlands:** Includes woodlots, tree windbreaks, bushes, shelterbelts, Christmas trees.
8. **Riparian Area:** Permanent vegetation (including native species, tame forages and shrubs) that is adjacent to any body of water (seasonal or permanent) – see photo below.
9. **Permanent Vegetation Corridor:** Permanent vegetation (native or tame) that is minimally influenced by agricultural practices and facilitates movement of wildlife across the landscape.
10. **Permanent Wetlands:** Any water body that typically contains open water throughout the entire year.
11. **Seasonal Wetlands:** Wetlands that only contain water during wet periods of the year (for example in the spring or after rainfall) they include most prairie potholes, ponds, sloughs, seasonally flooded meadows and marshes.
12. **Environmental Farm Plan:** A formal, written plan that is an overall assessment of environmental issues or concerns related to your operation.
13. **Beneficial Management Practices:** Farm management practices that enhance the quality of the environment as outlined in your environmental farm plan.



## Prize Draw Entry Form

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***"Economic, Greenhouse Gas and Policy Implications of Riparian Management on an Agricultural Landscape"***  
**Prize Draw Entry Form**

The prize draw is provided as a "thank-you" for assisting us in our study and is completely optional. This form will be stored separately from the survey thus ensuring your confidentiality. If you have any questions or concerns please call us at 966-1692.

To be entered into the prize draw please provide your name and phone number on the form below and indicate which prize you would prefer. Return this form in the provided postage paid envelope with your completed survey questionnaire. **DO NOT** staple this form to your survey questionnaire. Your name and contact information will remain confidential and you will only be contacted if you are a prize winner.

**Draw to be held on August 31<sup>st</sup>, 2007**

**Name:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**Prize Package**

- ☐ Hand Held Global Positioning System Unit  
or  
☐ Satellite Radio System + 1 year subscription

The value of each prize package is estimated to be \$200.

## Reminder Postcard

About 3 weeks ago, we sent you a questionnaire for our research study "*Economic, Greenhouse Gas and Policy Implications of Riparian Management on an Agricultural Landscape*". If you have already filled it out and returned it, please accept our thanks. If you have not gotten to it yet, please take some time to fill out the questionnaire and return it. Your responses to the questionnaire are important because they represent the views of many farmers like yourself and may be used to help guide agricultural policy in the future. If for some reason you did not receive a questionnaire, please contact me and I will send one out right away. Thanks again.

Sincerely,  
Amber Cuddington, M.Sc. candidate  
(306) 966-1692  
[adn336@mail.usask.ca](mailto:adn336@mail.usask.ca)

## APPENDIX B—COLLINEARILY TEST

	soil	payment	grain	acres	drained	perm	season	pests	aesthetic	erosion	costly	wildlife	equip
	1												
payment	-0.0015	1											
grain	0.1174	0.0583	1										
acres	-0.1876	-0.0817	0.1247	1									
drained	0.1869	0.0072	0.1081	0.2849	1								
perm	-0.1848	-0.1142	-0.0922	0.0497	0.0498	1							
season	-0.1578	-0.1081	-0.2029	-0.0897	-0.143	0.6197	1						
pests	-0.0559	-0.0268	0.1917	0.0204	0.0583	-0.2135	-0.1593	1					
aesthetic	-0.1489	-0.1366	-0.3742	-0.1733	-0.1777	0.2282	0.2468	-0.3091	1				
erosion	-0.185	-0.0863	-0.1462	0.0159	-0.1422	0.2599	0.2011	-0.2631	0.2988	1			
costly	-0.0183	0.1464	0.2463	0.1816	0.2512	-0.2096	-0.2095	0.363	-0.4047	-0.2521	1		
wildlife	-0.0017	-0.0661	-0.1223	-0.0603	-0.0398	0.2196	0.1256	-0.0848	0.2217	0.3055	-0.089	1	
equip	0.1561	0.087	0.2639	0.0901	0.2814	-0.094	-0.0598	0.1769	-0.2992	-0.1475	0.4001	-0.0919	1
benefit	-0.1723	0.0052	-0.2888	-0.2039	-0.2829	0.1773	0.2146	-0.4323	0.5622	0.4916	-0.5155	0.2166	-0.4449
age	-0.1217	-0.0177	-0.0609	-0.3101	-0.2644	0.0648	0.1496	0.0044	0.0569	-0.0287	-0.1221	-0.0633	-0.0583
mngtpl	-0.0491	0.0083	0.0829	0.227	-0.0355	0.051	-0.1086	0.1792	-0.0512	-0.0626	0.2142	-0.0081	0.1763
mngtm	-0.17	-0.037	-0.0848	-0.2184	-0.1871	0.2053	0.2237	-0.0248	0.067	0.0702	-0.0781	0.0012	-0.0938
educ	0.06	-0.1074	-0.0172	0.0249	0.2141	0.0356	-0.0283	-0.0286	0.1558	-0.0955	-0.0399	0.0098	0.0544
offinc	0.1458	0.1597	0.148	-0.1803	-0.0312	-0.1409	-0.0924	-0.041	-0.1204	-0.0159	0.0669	-0.0425	0.0022
heir	-0.0059	0.0573	-0.011	0.0382	-0.0746	-0.0547	-0.1563	-0.0006	0.0772	-0.0214	0.014	0.0303	-0.0078

benefit age mngtpl mngtm educ offinc heir

1						
-0.0306	1					
-0.2464	-0.0527	1				
-0.0423	0.8346	0.0251	1			
0.0715	-0.1802	0.0452	-0.2442	1		
-0.0342	-0.0178	-0.0267	-0.0873	0.0524	1	
0.0354	-0.069	0.1348	-0.06	0.0866	-0.2053	1